NATURE

No. 3986 SATURDAY, MARCH 23, 1946 Vol. 157

CONTENTS

	Page
Learned Societies and the Diffusion of Knowledge	349
Chemistry of Development. By Dr. C. H. Waddington	351
Britain of the Future. By R. Brightman	352
Oceanography and Meteorology. By Dr. G. E. R. Deacon, F.R.S.	353
The New Naturalist. By Major T. H. Hawkins	353
Biology and the Special Senses. By Dr. R. W. Pickford	354
Recent Research Work in the Davy Faraday Laboratory. By Dr. Kathleen Lonsdale, F.R.S.	355
Industrial Dermatitis. By Dr. J. Marshall	357
Geology of the Salt Range of the Punjab. By Sir Edward Bailey, F.R.S.	359
Collections of Micro-organisms	360
Obituaries :	
Prof. Charles Fabry, For.Mem.R.S. By Prof. F. J. M. Stratton, O.B.E.	362
Prof. F. R. Immer	362
Royal Society Elections	363
News and Views	364
Letters to the Editors :	
Pituitary Adrenotropic Hormone, Extract of Suprarenal Cortex, Lymph, and Lymphoid Tissue.—Prof. J. M. Yoffey, Dr. M. Reiss and J. S. Baxter	368
Tropomyosin : a New Asymmetric Protein Component of Muscle.—Dr. Kenneth Bailey	368
Absence of Pseudo-Cholinesterase from the Tissues of Ruminants.—Josephine M. Gunter	369
A Substance with Sympathin E Properties in Spleen Extracts.—Prof. U. S. v. Euler	369
Effect of Ions upon the Production of Vitamins in the Yeast Cells.—D. Rubinstein and L. Shekun	370
Preservation of Ascorbic Acid in Vegetables by Hydrogen Sulphide during Air-Drying.—Ettrup Petersen	370
Waterproofing Mechanism of an Insect Egg.—J. W. L. Beament	370
Extrusion of Nucleic Acid from the Nuclei of Human Granulocytes.—George Discombe	370
X-Ray Examination of Self-Recovery in Metals.—L. L. van Reijen	371
Electrical Properties of Tungsten Oxide Films.—Prof. F. Llewellyn Jones	371
Negative Resistance-Temperature Coefficient of Thin Evaporated Films of Bismuth.—T. J. Tulley	372
Nomenclature of Triterpene Alcohols.—Dr. J. C. E. Simpson	372
Constitution of the Dianhydrides of Sorbitol and Iditol.—R. Montgomery and Dr. L. F. Wiggins	372
Aggregation of Dyes in Aqueous Solution.—T. Vickerstaff and D. R. Lemin	373
A Light Reaction with Negative Temperature Coefficient.—Prof. K. Weber and S. Alperger	373
Are there Triflagellate Gametes in the Foraminifera ?—Dr. Margaret W. Jepps	374
Obligate Parasitism.—James Monroe Garner and David Gottlieb	374
Simple Photometric Method of Determining the Rate of Bacterial Growth.—N. V. Needham	374
Variation in the Rate of Growth of the Milk-Fish (*Chanos chanos*).—K. Chidambaram and M. Mukundan Unny	375
The Ecological Niche.—Kaare Münster Strøm	375
Potato 'Bolters' : an Explanation Based on Photoperiodism.—J. G. Hawkes	375
Incidence of Defective Colour Vision.—Squadron-Leader John Grieve	376
Relation Between Dark Adaptation and Age.—D. M. Steven	376
Need for the Development of Tropical Ecological Stations.—Dr. P. W. Richards ; E. J. H. Corner	377
Zavaritzky's Petrological Methods. By S. I. Tomkeieff	378
Glacial Geology in Holland during the War. By D. de Waard	379
Bowling-greens and Bowls. By J. H. Cole and Dr. W. Lawrence Balls, F.R.S.	380
Acceleration of Charged Particles	381
National Fruit Trials	382
Liverpool Observatory and Tidal Institute	382
The Donzellis. By Dr. M. Nierenstein	383

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad.

All rights reserved. Registered as a Newspaper at the General Post Office

LEARNED SOCIETIES AND THE DIFFUSION OF KNOWLEDGE

A NUMBER of papers contributed to symposia on "Science and the Modern Crisis" and "The Unity of Knowledge", arranged by the Manchester Literary and Philosophical Society, have since been reprinted under the title "Science, the Universities and the Modern Crisis" ; and through these papers runs a line of thought which is related to the topic of the presidential address delivered by Dr. Harlow Shapley in 1944 to the American Academy of Arts and Sciences (*Proc. Amer. Acad. Arts and Sci.*, **75**, No. 6, 131–139 ; 1944). Dr. Shapley was discussing the future of the Academy, and said that the problems of such a learned society are in large measure the result of history. One of the principal issues leading to the creation of scientific societies was the necessity of finding or creating a language common to the new dispensation, more accurate than literary language, and better shaped for the purpose than the technical vocabulary of scholasticism. Assuming that all parts of knowledge were equally accessible to any educated person and that the reporting of experiment and discovery in simple, rational and perspicuous words would render the results intelligible to all who participated in the style, the founders of the academies sought an instrument of language at once definite and clear in meaning, uncoloured by personal emotion, and unperplexed by rhetorical adornment. To this was added in the eighteenth century, when the American Philosophical Society was founded, the ideal of research for social ends, and the American Academy of Arts and Sciences was created in accordance with the view that public diffusion of knowledge was a virtue.

It was this view that tended in the eighteenth century to transform the transactions of the learned academies into important vehicles for the diffusion of knowledge. Their publications then served the functions to-day fulfilled by reports on research and discovery, university monographs, extension lectures, correspondence courses and technical trade journals. Universities were yet undeveloped, and industry was still simple and research foundations unknown, so the academy remained a dynamic centre for the intellectual world. With the increasing differentiation of knowledge in the nineteenth century, the taking over by government of functions originally developed by academies, the growth of research at the universities and elsewhere as well as the establishment of foundations for the encouragement of research, the academies began to decline in importance and their field narrowed.

The way in which the growth of professional associations and the development of industrial research or other agencies have weakened the influence of the academies is well indicated by Dr. Shapley, but he proceeds to discuss two developments which in the twentieth century, by tending to reverse the trend to fractionate knowledge, are giving a new importance to the academies. In some sense, he suggests, specialism has defeated itself. What once

looked like a separate compartment of knowledge, unique and apart from everything else, the more it is explored, the more its boundary lines seem to waver and vanish. The relation of fields is not that of pigeon-holes, but of living inter-dependent cells.

That point of view might also be said to be emphasized by the lessons of team-work during the War, whether we think of radar, of atomic energy or of the other fields which Dr. Lander discussed recently; and the point was well made by Prof. B. Dobrée who, in the Manchester discussion already noted, urged that there is no frontier and that all knowledge is one if we have the power to make it so and the will to use that power. A second reason for unity, however, the argument that if we do not recover a common set of ideas, a common tradition and a common language, we are lost, which is also analysed by Dr. Shapley, was a main theme in Prof. Manson's paper and in that of Miss D. M. Emmet. While Dr. Shapley points out that the unity of classical culture or the medieval world was less perfect and comprehensive than is often suggested, he regards it as an argument of weight, and discussing first where the intercommunication of knowledge can best take place, he regards the academies as of outstanding importance as institutions in which specialists can talk to each other, and as therefore likely to be far more effective than either the university or special congresses.

Dr. Shapley, in fact, scarcely returns to the problems arising out of the other question which he propounds—what knowledge is to be intercommunicated—and the remainder of his address analyses the contribution which the academy, with its freedom from the departmental rivalries of a university and its greater stability than the annual congress, might make in the machinery of communication; and the changes in its own organisation and activities that might be required. In the first place, he maintains that the encouragement of research is the primary business of the academy; the spirit of research at advanced levels rather than the spirit of reporting even at high levels is essential to its healthy life. The research spirit, he observes, does not depend upon vocabulary but upon an exciting philosophy of values; and institutions are stimulating, not when scientific men such as chemists are concerned lest the literary critics should not understand them, but when scientific and literary critic are alike committed to an exciting intellectual existence. Learned institutions, he believes, grew or declined, were active or dormant, in proportion as they dared to foster great projects, dream of great issues, and embark upon great and important programmes.

It was in this spirit that Dr. Shapley suggested the American Academy of Arts and Sciences should recapture the spirit of its founding fathers in 1785 and consider its responsibility for the intellectual life of New England, and the possibility of becoming a focal point for joint enterprise and co-operative projects covering all the problems of the region. For this purpose he suggests the creation of a special commission of fellows of the Academy to review and re-examine the whole structure, including the repair and modernization of its building and the increase of its endowment to undertake programmes of the type indicated. Rich as is New England in institutions of learning, Dr. Shapley believes that some positive programme linking together the interests of the learned and the problems of society in the years immediately to come would be welcomed, and he hoped that the American Academy would take the lead.

The particular appeal with which Dr. Shapley closes his address does not mask the similarity of his trend of thought to much that was voiced at the symposia at Manchester; symposia which, it will be noted, were sponsored by the oldest and best known of academies in Great Britain, in the sense in which he uses the word. Prof. Dobrée, for example, suggested that if science is to help in solving the ethical problems of our age, it must lend itself to the creation of a synthesis of knowledge, to the pursuit of a harmony of outlook involving the integration of conflicting assumptions, and that learning which is grouped in other faculties must do likewise, especially in making a closer approach to the new sciences; all branches of learning must take account of ends. All must recognize that the proper study of mankind is man, and they must search for the order which underlies the knowable universe.

Miss Dorothy Emmet deprecated any attempt to achieve unity of thought by the imposition of an ideology, and suggested that a synthesis in the grand manner is improbable; she believes that intercommunication offers its own exacting and exciting adventure, and that if we cannot see external unity in the pattern of knowledge, the intellectual world can nevertheless be held together in the internal bond of certain common convictions. Such convictions, she believes, may give us the spirit out of which the unity of a cultural community can grow, and out of which in the long run a new synthesis may come.

Only those who are faithful to the demands of their own discipline are, as Miss Emmet said, likely to have anything to communicate, and that needs to be kept in mind in considering Prof. T. W. Manson's observations on the functions of a university, leading to his appeal that the life of the individual should be an integrated whole. No graduate, he urged, should leave a university with a profound knowledge of his own subject and a profound ignorance of every other. Workers in different fields of research should make it their business to find ways of communicating with one another; and without relaxing their efforts in their own sphere they should be eager to know what is going on elsewhere. Prof. Manson himself recognizes, like Prof. A. D. Ritchie, that specialization has its place and its contribution; but in his view of the failure of the university as a cultural unit and its dismemberment by the segregation, exclusiveness, and attempted self-sufficiency of the departments, there is little of the vision that marked Dr. Shapley's address. Mr. R. D. Waller indeed sensed some of the

possibilities of extra-mural studies in restoring a sense of the unity of knowledge and creating a new idea of a university valid for the modern age; through such enterprise the relevance or irrelevance of their own knowledge to the common problems of men and women in this age might be brought home to students of the sciences and of the humanities.

Apart from this, it must be admitted that the Manchester discussions were negative rather than constructive, and it is curious that in the single reference to team-work Prof. Manson was concerned rather with its limitation than with its possibilities. Nowhere was there any suggestion of possibilities of team-work as demonstrated in our experience in war-time, or of the lessons to be drawn from that experience for our attack on the intellectual and ethical problems of to-day no less than the material problems of the post-war world. "One great lesson which a survey of work on antibiotics should have taught us," said Sir H. W. Florey last October in his Lister Memorial Lecture, "is that real and continuous progress and understanding can be obtained only by the collaboration of people with various outlooks and experimental accomplishments." The problem is indeed formulated in a measure; but its immediate relevance to those which arise in the development and expansion of the universities was not explored, and it is not related at all to a programme of practical action as is done by Dr. Shapley.

That may indeed endorse the value of Dr. Shapley's contention that the academies rather than the universities are likely to play the decisive part in the intercommunication of knowledge, for there is no reason to believe that British scientific workers are any less concerned with the position than their American colleagues. The activities of the Royal Society and of the British Association are sufficient evidence to the contrary, and there is plenty of evidence that some universities at least are alive to the importance of their extra-mural activities. The place of the universities in regional life could not be better put than has been done by Prof. Dobrée or by Bruce Truscot in his recent book.

There are, of course, further reasons why the various faculties of arts should be restored to full strength as early as possible. It may not be solely to that faculty that we should look for a re-interpretation and philosophy of life, for a distinctive contribution to the unification of knowledge and a sense of values; but without it there can be neither the balance nor the effective stimulus to the creative thinking and steadfast vision through which alone we can regain our control over events.

There is imperative need of the stocktaking to which Dr. Shapley called the American Academy, and that call should be addressed to the universities as well as to the learned institutions outside their walls. The questions raised in his address and in the discussions before the Manchester Literary and Philosophical Society need to be kept clearly in mind when we consider such matters as the post-war expansion and re-organisation of universities, or the complex problems such as are raised by the utilization of atomic energy. We have to elaborate the forms of organisation by which our learned institutions, whether they be universities or scientific societies, can best serve the needs of the present age; and the solution to that problem will largely be achieved pragmatically as Dr. Shapley suggests, as men and women of different experience and trained to varied disciplines co-operate in the attack on common problems.

None the less, there remains the need for creative thinking, in the elaboration of appropriate machinery and also in the re-integration of knowledge and the formulation of a vision and a faith which men and women will find as inspiring and compelling as the demands of war-time. We do well to remember that again and again the stimulus to such creative thought and achievement has come from those borderlands of the sciences where workers from different fields have been brought together in the attack on some problem of common interest. It is at least possible that out of the team-work so brilliantly demonstrated in the War may come not merely the solution of many of the material problems of the peace, but also the creative thought which will give mankind a new synthesis of knowledge, a fresh vision and hope, and a philosophy and faith which will help him to put his moral and spiritual development in step with his material advance.

CHEMISTRY OF DEVELOPMENT

Embryologie Chimique

Par Prof. Jean Brachet. Pp. 510+3 plates. (Liège: Desoer. Paris: Masson et Cie., 1944.) n.p.

DURING the last quarter of a century, the analytical study of development has been passing through a very rapid evolution. Spemann's discovery of the organiser towards the end of the First World War provided the first example of a phase of differentiation dependent on a known process of cause and effect, and it initiated an intensive search for other instances where one could abandon the somewhat philosophical notions of potency and regulation and substitute for them the analytically more satisfying concepts of organisers, competencies and so on. There followed a widespread movement of enthusiastic experimentation which profoundly deepened our understanding of the developmental process in echinoderms, insects, fish, birds, mammals and other groups. This continued right up to the outbreak of the Second World War, and will, it is to be hoped, be resumed as conditions return to normal, since much still remains to be done. But a second phase in the attack has already started. Beginning with the discovery of the evocating activity of killed organisers in Amphibia and chicks in 1932, investigations were started in a number of laboratories on the nature of the active substance; and these were, by the logic of events, forced to broaden themselves into studies of the connexions between metabolic processes and the determination of development. They thus came into contact with earlier work on the biochemical constituents and activities of eggs and embryos, much of which had originally no exactly known relevance to the phenomena of differentiation.

By now this broadly based biochemical study of development is in full swing.

Prof. Jean Brachet has played an important part in both aspects of biochemical embryology. His earlier work was concerned with the increase in the quantity of thymo-nucleic acid in the early stages of development and issued in the suggestion of what was called a 'partial synthesis' of this from an original store of ribose-nucleic acid. At the time (1931–33) there was little reason for supposing that the substance studied was intimately connected with the processes which cause differentiated tissues to appear; and Brachet passed on to make important contributions to the more obviously crucial problem of the organiser and its oxidative metabolism. The relevance of this background is very clear in relation to his recent book, copies of which have now become available in England. While this does not attempt the encyclopædic exhaustiveness of Needham's "Chemical Embryology" and "Biochemistry and Morphogenesis", it is written on generous lines, with a bibliography of more than a thousand items. Apart from one or two rather isolated sections (there is, for example, a very clear summary of the recent work on sex determination, particularly that of the German school on *Chlamydomonas*), the main topics are ones to which Brachet has himself contributed, and which he handles with the intimate understanding that only actual participation can give. Naturally, also, the fact that the author is actively assisting in the advancement of the subject is reason enough why we should not be surprised to find that his discussion tends sometimes to overstep the limits of the known, and to include suggestions and speculations which call aloud for fuller investigation.

In his most important theory, Brachet returns to the subject of nucleic acid. Since his earlier work, important advances have been made by nuclear cytologists in distinguishing between eu- and heterochromatin in respect of properties of 'stainability' which are usually attributed to the presence of desoxyribose nucleic acid, and this distinction has been correlated with the genetic activity or inertness of segments of the chromosome. Caspersson has traced, by means of the ultra-violet spectroscope, the changing location of purine groups which are considered to be constituents of nucleic acids. Brachet has added to this a much fuller study than previous authors of the results of digestion of cell structures with nucleases, a method of analysis which yields some of the most compelling evidence that the so-called nucleic acids of the chromosomes really are such. Brachet has employed purified enzymes which he claims to have shown to be specific, in one case for desoxyribose nucleic acid and in the other for ribose nucleic acid. Much turns, of course, on the purity and specificity of these extracts; and for details of their preparation and properties, the original papers must be consulted. If one accepts this specificity as demonstrated, Brachet's method enables one to distinguish between the two types of acid more accurately than is possible by means of the previous ultra-violet-Feulgen technique, and considerable additions can be made to the story as described by Caspersson.

One of the most important new elements which Brachet brings into the picture are certain cytoplasmic granules which can be concentrated from many types of cells by ultracentrifugation. They contain ribose nucleic acid in a 'fixed' condition (that is, united with protein); and a considerable number of enzymes, including cytochromoxidase and various hydrolases and desmolases, appear to be bound more or less firmly to them. Brachet compares them to the granules isolated by Claude originally from fowl tumours; and he brings forward a number of reasons for supposing that such particles are important sites of protein synthesis in cells, and thus presumably ultimately dependent on the genes which control cell differentiation.

The intimate involvement of nucleic acid with the fundamental processes of development is not exhausted by this. It has been known for some years that nucleic acids could cause evocation of a neural plate in the newt, a fact which its discoverers attributed merely to an 'acid stimulus', and which could certainly be explained if the acidity were sufficient to cause any damage to the cells. Brachet, however, believes that the relation is more important and more specific than this. He brings forward evidence (not of a very satisfactory nature, perhaps) of a diminution in ribonucleoprotein in the newly invaginated mesoderm and an increase in the newly induced neural plate, and puts forward a number of arguments to support the theory that the normal process of evocation is caused by a diffusion of similar substances. The most direct evidence is derived from experiments in which dead tissues were shown to lose their power of evocation after digestion with a nuclease. The whole question is still extremely involved and will need much further study before it is fully clarified. But there is no doubt that Brachet's theory is of the first importance as an attempt at synthesis in the complicated field which includes the 'inactive evocator complex', Claude's particles, Darlington's 'plasmagenes', the chemical effects of carcinogens, the activation of the nuclear genes, nucleoprotein respiratory enzymes and similar phenomena.

C. H. Waddington.

BRITAIN OF THE FUTURE

Post-War Britain

Edited by Sir James Marchant. Pp. xv + 240 + 8 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1945.) 12*s.* 6*d.* net.

THE essays which Sir James Marchant has collected in this volume under an introduction by Lord Woolton are similar in type and purpose to those articles on applications of science which the British Association commenced to publish last year in *The Advancement of Science*. Each of its kind is excellent. The essays are practical and non-political, sometimes idealistic rather than realistic, and the technicalities are handled with skill. It is too much to claim that "they form the most authoritative blue-print for our national life yet presented to the public"; but they represent a most admirable attempt to interpret to the general reader some of the recent developments and trends in applied science and their bearing on, and potentialities for, the problems that confront us in post-war reconstruction.

Lord Horder contributes an essay on the future health of the nation in which he relates the contribution to be made by the State, the medical profession, agriculture, nutritional science, industry, education and the citizen himself and puts the various elements into a perspective that should assist the citizen to arrive at a sound and independent judgment for himself on questions of current discussion. Sir John

Orr's contribution "The Food of the Future" develops one aspect of this theme further and in particular stresses the significance of the Food and Agricultural Organisation of which he has since been appointed director general. Sir Ernest Simon condenses into an essay on "Building the Homes of the People" the gist of his book "Rebuilding Britain—A Twenty Year Plan", while Prof. A. W. Ashby contributes a retrospect and a prospect of agriculture which reviews both the modern history of the industry and the wider social issues involved which should facilitate realistic and unprejudiced thinking on this question. The late Dr. E. F. Armstrong in some fifteen pages contrived to explain some of the recent contributions of synthetic organic chemistry in regard to nutrition, the treatment of disease, the new textiles, transport, building materials, lighting and heating, while the mechanical aspects and applications of plastics are dealt with at greater length by Dr. E. G. Couzens. Dr. A. Parker gives a comprehensive review of the coal position including its use as a source of oils and chemicals as well as a fuel. Iron and steel developments are discussed by Dr. C. H. Desch, railway and allied transport by Sir William V. Wood and the future development of electrification by Mr. J. M. Donaldson, while in the concluding essay Sir Edward Appleton gives a very brief account of the organisation of scientific research in Great Britain.

The book is well written and produced. It possesses more homogeneity than most of its type, and if there are obvious gaps in the picture it presents of our national life, regarded as a blue-print for the future, it does give a lucid and readable account of the contribution which science might make to human welfare on the material plane and the conditions under which that contribution could be effective. But if the text is excellent a word of protest is called for in regard to the illustrations. These are singularly ill-related to the text and bear no evidence of any care or thought in selection. If illustrations are to be included in a book of this quality they should be chosen and placed with the same care that has been bestowed on the text and at least serve to exemplify or elucidate some point made in the text. Not one of the eight included in the present volume serves any purpose, and one at least—that facing page 141—is an insult to any intelligent reader.

R. BRIGHTMAN.

OCEANOGRAPHY AND METEOROLOGY

Oceanography for Meteorologists

By Prof. H. U. Sverdrup. Pp. xv+235. (London: George Allen and Unwin, Ltd., 1945.) 12*s*. 6*d*. net.

BY explaining the methods and findings of oceanography, the author seeks to convince meteorologists that the atmosphere and oceans cannot be studied independently. He maintains that the currents, and temperature and salinity distributions in the oceans represent a dynamic equilibrium between radiation, conduction, evaporation, precipitation and the effect of the winds, and urges that this interaction has not yet received sufficient attention in meteorology. By attributing such neglect largely to the absence of an adequate book from which a meteorologist can readily obtain information on the findings of oceanography, he places most of the blame on oceanographers.

It is to satisfy such a requirement that the present book was written. It was first published in the United States in 1941, and is built up from the sections most interesting to meteorologists from the larger book, "The Oceans", which the author was then preparing in conjunction with his colleagues, M. W. Johnson and R. H. Fleming (see *Nature*, 155, 652; 1945). Most space is devoted to the oceanography of the surface waters and interaction with the atmosphere; but since the conditions near the surface depend to a large extent on the deep water circulation, this is also discussed.

The applications of hydrodynamical theory to the study of the distribution of physical and chemical properties in the ocean are very similar to the treatment of corresponding problems in meteorology; and as meteorologists turn to the use of distinguishing properties of air masses the two sciences have more in common. It is not so easy to make a synoptic chart for the oceans, since the pressure distribution has to be calculated from vertical series of temperature and salinity observations; but the oceanographer has an advantage in distinguishing mass movements, because the open sea is always stably stratified and vertical movement restricted, and because he has a greater number of distinctive physical and chemical properties to choose from.

Prof. Sverdrup has done both sciences a great service by providing such an authoritative account which should stimulate co-operation. In many parts of the book the need for new data, or confirmatory observations, is emphasized, and it is evident that a moderate extension of the facilities for research would give much impetus to studies which are of equal importance whether considered from the meteorological or oceanographical point of view.

G. E. R. DEACON.

THE NEW NATURALIST

(1) London's Natural History

By R. S. R. Fitter. (The New Naturalist Series, No. 3.) Pp. xii + 282 + 72 plates. (London: Wm. Collins, Sons and Co., Ltd., 1945.) 16*s*. net.

(2) Butterflies

By Dr. E. B. Ford. (The New Naturalist Series, No. 1.) Pp. xiv + 368 + 72 plates. (London: Wm. Collins, Sons and Co., Ltd., 1945.) 16*s*. net.

INTERPRETING the mood of the times, the editors of this new series are presenting a number of books which they hope will help to recapture the inquiring and enthusiastic spirit of the old naturalists. Lately, as the editors are well aware, there have been many indications that it is once more being recognized that natural history is not inferior to science but is, indeed, an important part of science. This was shown, for example, in a biology syllabus for sixth forms which was recently prepared by the Cambridge Joint Advisory Committee for Biology. The syllabus recommended that, in order to avoid the common complaint that whereas many botany students can discourse learnedly on a cross-section of the stem of *Tilia europeea*, they are unable to recognize the common lime when they see it, about a quarter of the time allotted to biology should be devoted to a study of plants and animals in their natural surroundings.

For inquiring naturalists not much needs to be said of the value of this new series. Fitter's book

would be an admirable counsellor to anyone who lives or has lived within twenty miles of Bow Bells; Ford's would be acceptable to anyone with leanings to the Lepidoptera who lived or has lived in Great Britain. If companion volumes—of which we are promised "British Game" by Brian Vesey-Fitzgerald and "Britain's Structure and Scenery" by Dudley Stamp—maintain this standard, their success is assured.

A common feature of the two books deserves special notice. These are the colour photographs which, on the whole, since they entail new techniques in colour printing, succeed beyond expectation. They fail occasionally in Fitter's book, particularly where attempts have been made to delineate fine details of flowers. But the general success of this colour photography is a happy introduction to things to come, and, when more experience of its use has been gained, will in itself do much to re-create the spirit of the old naturalists.

"London's Natural History" would be acceptable to anyone interested in the historical development of London with particular reference to its biotic environment. There are enough maps and diagrams to enable one to interpret the growth of the city in relation to the prevailing fauna, flora, and geological features, while a series of chapters on the influence of trade and traffic, water supply, refuse disposal, smoke, food-getting, sport and the Second World War shows how thoroughly the author has explored the natural history of London.

The value of Ford's book is that it is not just another compendium of butterflies but treats of their general biology and of the more important phenomena met with in studying them in these islands. Not the least valuable part of "Butterflies" is the way in which the author creates interest in a problem and then throws out concrete suggestions which could be taken up by his 'general readers' as research projects.

Which brings one to the question: Who is the general reader for whom these books are intended? Certainly they would not be suitable for the intelligent layman who reads casually to pass an hour away. The general reader here would rather need to be a person of good academic standing in a particular subject, well used to pondering over his reading and wishing to develop his interest in natural history; for him these books would be eminently suitable.

One small point in conclusion. Ford might check up on the location of the Forest of Dean. If the statement in his book is correct, then one west countryman has been shamefully deceived about the county of his birth.

T. H. Hawkins.

BIOLOGY AND THE SPECIAL SENSES

Aux sources de la connaissance

La sensation, guide de vie. Par Prof. Henri Piéron. (L'Avenir de la science, Nouvelle Série, No. 3.) Pp. 420. (Paris: Libr. Gallimard, 1945.) 320 francs.

THIS book is a welcome addition to the study of the special senses, for two reasons: first, because it gives that study a biological setting; and secondly, because it includes excellent discussions of recent scientific research.

The bulk of Prof. Piéron's book is a distinguished and excellently systematized report upon experimental researches on the special senses. He deals in Part 1 with the functions of the senses in the biological regulation of behaviour, with the differentiation and classification of sensations and with their general characteristics of intensity, extensity and duration. In Part 2 he deals with the mechanisms of sensory excitation; in Part 3 with the fundamental qualities of colour, tone, smell and taste. Part 4 is concerned with the detailed experimental analysis of quantitative aspects of sensation in relation to space, time and intensity, and with the underlying physiological mechanisms upon which quantitative differences in the sensory fields depend.

Throughout all this detailed review of his subject, Prof. Piéron has incorporated numerous references to recent research, and he has brought it into relation with the older and more familiar work. In colour vision, however, it is possibly sad to see him dismissing the Hering theory in an unduly brusque manner, and not taking more seriously Houstoun's adaptation of the four-colour theory. This would have been a simpler way of meeting the very complex facts of colour sensitivity and its variations than his involved though fascinating adaptation of the Young-Helmholtz theory. It is also perhaps strange that experiments, however brilliant, upon the retinæ of animals like the frog, grass-snake, rat and guinea pig, which appear to be totally colour-blind, can be expected to throw any direct light on human colour vision; but the importance of the experiments themselves is still very great. Prof. Piéron's study of hearing is most interesting, and in general his treatment of the many physical and physiological problems of sensation is distinguished by a synthetic grasp and an adequate scientific scepticism.

The biological setting which he gives to the study of the special senses means much. It takes that science out of the realm of 'systematic psychology', which in the past has been somewhat arid because it was too often an attempt to reconstruct conscious knowledge from elements of sensation or sensory particles. Instead Prof. Piéron begins with behaviour and proceeds to show how the activities of the living organism are guided and regulated by the influence of the environment. It is clear that the control and regulation of behaviour is a dual system; on one hand subject to the guidance of the special senses, on the other dependent upon the inner organisation of the living animal and its many and complex tendencies to enter into relation with the world around it. This book, however, is a study of the special senses and of the parts they play, and is subject to appropriate limitations throughout. At the end Prof. Piéron says that the special senses, far from being windows which open on to the outside world, are complex forms of apparatus for the detection of minute chemical, mechanical and photo-electric changes in the environment. These changes, once detected, translate themselves into conscious sensations and perceptions, forms of symbolism universal because of the essential similarities of organisms in Nature. Although in each of us our consciousness is uniquely our own, we apprehend through it a common universe by the universal symbolism of sensory functions.

Prof. Piéron is to be congratulated upon the production of a delightful book, one which is just what we want—a complete, biological and scientifically adequate treatment of this immensely interesting subject, the science of the special senses. It is to be hoped that an English translation will soon be available.

R. W. Pickford.

RECENT RESEARCH WORK IN THE DAVY FARADAY LABORATORY*

By DR. KATHLEEN LONSDALE, F.R.S.

FOR many years after Sir William Bragg moved, with his research team, to the Davy Faraday Laboratory in 1923, their work was confined almost exclusively to the development of powerful X-ray tubes on one hand, and on the other to problems relating to the arrangement of atoms and molecules, and later the distribution of electron density, in crystals of organic compounds. Many members of that research team, now themselves leaders of research, are carrying on structural investigations, on more complex substances, in various parts of the world.

In the Davy Faraday Laboratory itself, recent fundamental research work carried out since about 1940 has proceeded along three main lines: (1) A study of the *vibrations* of atoms in crystals, the way in which those vibrations vary with temperature and with the elastic properties of the crystal as a whole, and the resulting *anisotropy of the thermal expansion* of non-cubic structures; (2) a study of the *sub-crystalline changes of structure* which accompany the very large changes of electrical properties of such crystals as Rochelle salt, KH_2PO_4, and KH_2AsO_4 at their respective transition points; (3) a study of the *texture* of various crystals by means of Laue photographs and of divergent X-ray beam photographs, including precision measurements of the *variation of lattice spacing* in individual single crystals.

Any model of a crystal structure represents an ideal and unrealizable case; the atoms are never all in their mean lattice positions simultaneously, even at the absolute zero of temperature. At all other temperatures the atoms in a crystal are continually moving, not very far, but very fast. They vibrate about their mean lattice positions with a frequency of the order of 10^{13}/sec., so that in twenty-four hours at ordinary temperatures the atoms of common salt each travel about 50,000 miles, although they are never more than an average of about 0·23 A. from their respective lattice points, just as a housewife may walk several miles about the house during the working day, and yet never be more than a few yards from her kitchen. James and Firth showed, some twenty years ago, that the root mean square amplitudes of vibration of the sodium and chlorine atoms in rocksalt are different. In general, metallic atoms are more loosely bound, in the crystalline state, than the atoms with which they combine. This fact helps to explain such processes as the oxidation of FeO, through Fe_3O_4, to Fe_2O_3; the high ionic conductivity of γ AgI, and metallic diffusion in general. The intensity of X-ray reflexion from a set of crystal planes has a maximum value when the atoms all lie in the planes, and is reduced when the atoms are displaced. The vibration of the atoms will therefore reduce the intensity of Bragg reflexion by an amount depending upon the amplitude (and therefore on the temperature, since the amplitude increases with temperature); and the effect is greater, the smaller the spacing of the planes, just as a fidgety person near at hand is more trying than one at a distance. Laue photographs of single crystals taken at different temperatures show, however, that accompanying the *diminution* of Bragg reflexion with rising temperature, there is an *increase* of intensity of certain diffuse and often curiously shaped spots (patches or streaks), which do not appear to obey the Bragg law, although they are undoubtedly produced by the characteristic X-radiation employed[1]. To what are these due, and what can they tell us?

The vibrations of the individual atoms in the crystal, although giving rise at any instant to apparently random displacements, are really controlled by crystal forces which must themselves be periodic. The movements of the atoms can therefore be mathematically treated as due to the superposition of large numbers of waves of various frequencies, polarizations, wave-lengths and amplitudes, just as the movements of the water molecules in a pond are due to a great many superimposed ripples. Long waves can have large amplitudes without very much disturbing the *relative* positions of neighbouring atoms. Very short waves cannot, and since the atoms will resist large relative displacement, short waves will in general have small amplitudes. It is, however, the large displacements that affect the intensity of X-ray scattering most, and it is therefore the long waves that are largely responsible for the reduction of Bragg intensity and the increase of diffuse scattering as the temperature rises, although short waves of large amplitude may occur in special cases and at temperatures near the melting-point. The effect of one single wave in a crystal lattice is to introduce a *super-lattice*, a phenomenon well known in the study of alloys and of diffraction gratings generally. A super-lattice implies new periodicities and must introduce new spectra. Since each wave thus introduces extra reflexions, it seems surprising that a complex system of waves of all sorts and sizes should give us, on Laue photographs, such neat patterns of diffuse spots and streaks. We have to remember, however, that Laue photographs of a single crystal can be taken in an infinite number of different orientations, and that the diffuse pattern observed varies from one orientation to another, so that we are, by means of each separate photograph, selecting for observation only a few waves at a time. No modification of the frequency of the scattered X-rays is observable, because the change of frequency is too small. The frequency of X-rays is 10^{18}/sec., or 100,000 times as great as that of the thermal waves, and therefore, so far as X-rays are concerned, these waves are stationary; in other words, seen by means of X-rays, the atoms are merely displaced, not actually moving.

The total scattering due to a regular atomic arrangement on which is impressed a system of new periodicities can be ascertained theoretically, and Waller, Jahn and Born have given formulæ[2] relating the particular scattering of X-rays to be expected in any given crystal orientation, for cubic crystals, with the quasi-elastic forces which control the thermal movements of the atoms, forces which are themselves related to the elastic properties of the crystal as a whole, its compressibility, resistance to shear, Young's modulus and so on. There are a number of cubic crystals for which the elastic properties are fully known, and in all the cases tried (rocksalt, sylvine, sodium, lithium, lead and tungsten) the scattering experimentally observed agrees well with the theoretical predictions. Even for less symmetrical crystals, it is possible to deduce, on general principles, the kind of thermal scattering to be expected for layer lattices, such as graphite or hexamethylbenzene, and for chain lattices, such as those

* Substance of lectures delivered at the Royal Institution on November 20 and 27.

of the paraffins, fatty acids and so on. It is to be expected, for example, that the atoms will be displaced more easily in directions perpendicular to, than parallel to, layer planes, and that therefore such planes will show particularly large variations in Bragg intensity with temperature, and particularly large extra thermal scattering effects. The atoms in chain molecules can move more easily in directions perpendicular to, than parallel to, the chain-length[3], and the result of this is that crystal planes perpendicular to the length of the chain-molecules give extra thermal scattering effects of a peculiarly streaky shape. The shapes and intensities of the thermal spots and streaks can, in fact, be used as a means of determining molecular orientation in crystals[4]. With a development of the technique of obtaining really monochromatic radiation, it should not be difficult to reverse the original procedure, and to use the thermal scattering as a means of determining the elastic constants of crystals, a method that would have the advantage of introducing no kind of large-scale crystal deformation. In interpreting observed effects, care must be taken that other possible sources of extra scattering, such as small crystallite size, or static irregularities of spacing, inclination or density of crystal planes (variations which frequently exist, for example, in alloys during the course of, or as the result of, heat-treatment or ageing) are eliminated or allowed for. The passage of X-rays themselves will, of course, produce heating up of the crystal, but this is only a matter of a few degrees (X-rays can, for example, bore a neat hole in a thin sheet of ice), and the thermal atomic vibrations thus produced are intrinsically no different from any other thermal vibrations.

The expansion of a crystal that usually takes place with rise of temperature is a direct consequence of the increased amplitude of the atomic vibrations. In the case of molecular compounds, however, the anisotropy of the expansion is not always the direct consequence of a similar anisotropy of thermal vibration; it may result from a re-orientation of the molecules as a whole, since the geometry of a crystal structure is very dependent upon the way in which vibrating molecules most readily 'dovetail' together, and this varies with the shape and field of force of each molecule. The structure and thermal expansion of the phthalocyanines[5] provide an excellent example of the way in which the substitution of a heavy atom for a light one may alter not only the molecular arrangement at any given temperature, but also the relative variation of that arrangement over a range of temperature. The values of the principal coefficients of expansion, $\Delta d/d$ per °C., over the whole range −183° to 400° C., are as follows:

		H phthalocyanine	Pt phthalocyanine
In (010) plane	max.	$0{\cdot}75 \times 10^{-4}$	$0{\cdot}60 \times 10^{-4}$
	min.	$0{\cdot}40 \times 10^{-4}$	$-0{\cdot}14 \times 10^{-4}$
Normal to (010) plane		$0{\cdot}18 \times 10^{-4}$	$1{\cdot}18 \times 10^{-4}$

The turning of the platinum phthalocyanine molecules causes a contraction in one direction as the temperature rises, but this is more than compensated by the expansion along the *b* axis.

Some crystals, however, do not show a steady change of dimensions with temperature. Rochelle salt (NaK tartrate . $4H_2O$) and potassium dihydrogen phosphate (KH_2PO_4) are reported to show definite anomalies at certain temperatures, and these are associated with abrupt changes in the specific heat and more particularly with enormous changes in the values of the dielectric constant and piezo-electric modulus. This increase of dielectric constant is analogous in many respects to the increase in permeability that occurs when iron and some other metals and alloys become ferromagnetic, and the temperature at which the change takes place is, by analogy, called the electrical *Curie point*. In the case of Rochelle salt, however, there is a lower Curie point at which the large values of the dielectric constant and piezo-electric modulus decrease again to more ordinary values. The Curie region extends from about − 20° to + 25° C., and the change of electrical properties is largely confined to one crystallographic direction, the *a* axis. The upper Curie point of potassium dihydrogen phosphate is at about − 150° C., and the unique axis in that case is the *c* (tetragonal) axis. Now abrupt changes of crystal properties, such as thermal expansion and specific heat, are usually associated with a transition point, or change of crystal structure. There is such a change in the case of Rochelle salt, but it is so small that only the most careful measurements have revealed it[6]. The angle between the original orthorhombic *b* and *c* axes changes from 90° to 89° 58′ or 90° 2′; the crystal, therefore, has become monoclinic in the Curie region; but the change involved is so small that it may be reversed (either by lowering the temperature below − 20° C. or by raising it above + 25° C.) without any appreciable powdering of the single crystal used. The change can be followed by observing the doubling of certain X-ray reflexions as the temperature changes, and their reversion to single lines. For potassium dihydrogen phosphate the change of angle is larger. The tetragonal unit cell becomes orthorhombic, the original *a* and *b* axes become the diagonals of the new orthorhombic (001) face, and the angle between them changes from 90° to 89° 33′ or 90° 27′. The (nearly) parallel tetragonal crystallites of which the original single crystal was made up do not all change in the same sense; Laue photographs show that within the Curie region there are four preferred orientations (in the absence of pressure or of an applied field), but that at temperatures above the Curie point the multiple reflexions again coalesce to give the single reflexions characteristic of a single mosaic crystal[7]. The transition at the Curie point is not sharp. Like the change in electrical properties, it extends over a range of several degrees before it is complete.

Thermal expansion measurements indicate that the anomalies are associated with changes in the lengths of the hydrogen bonds in both crystals and these, combined with changes in the mobility of the hydrogen atoms, may perhaps account for the dielectric and piezo-electric properties. Research on these and other points is still in progress; but it is clear that in these compounds large changes of physical properties are associated with very small changes of crystal structure and texture.

This is not altogether surprising, for there are well-known cases where a change of texture alone is sufficient to cause a big change of physical properties; compare, for example, the mechanical strengths of single and composite metal crystals. This is a question of considerable practical importance, and for that reason, if for no other, methods of studying crystal texture are very desirable. Very few single crystals are perfect. Those that are, are poor reflectors of X-rays, because the rays scattered by an exactly regular arrangement of atoms bear a definite phase relationship to one another of such a nature as to result in destructive interference and partial annihila-

tion of both the reflected and the transmitted beams. The reflecting power is, in effect, confined to a crystal skin of thickness about 0·001 mm., and the remainder of the crystal is quite ineffective. The exact parallelism of the crystal planes also ensures that only a very small range of incident angles is effectively employed. Both these factors contribute to what is known as the *primary extinction* of perfect crystals.

But most 'single crystals' are mosaics of small crystallites, orientated more or less similarly but with small discontinuities of spacing or direction at frequent intervals. If the crystallites are large and disorientated, or if there is, for example, a regular change of orientation within the single crystal, then Laue photographs are useful. They have shown, for example, that slight spiralling is not uncommon as the result of natural growth or mechanical treatment[8]. If the crystallites are extremely small, diffuse scattering will sometimes reveal their size and shape (as in the case of the micelles of fibres, or the segregation of new and incipient crystalline phases from certain alloys during heat-treatment or age-hardening). Crystallites of medium size, say 0·001–0·00001 mm. linear dimensions, are not so easy to study. They do not show primary extinction, because there are no phase relationships between the rays scattered by one crystallite and another; they are 'all skin'. But the total reflecting power of the composite crystal is less than the sum of the reflecting powers of the individual crystallites would be if each were separately bathed in the incident X-ray beam appropriate to its position. This is because, in the case of the composite crystal, the incident beam is reduced by reflexion as well as by ordinary absorption before it reaches the lower layers of crystallites. *Secondary extinction*, as this diminution of total reflecting power of a mosaic crystal is called, is therefore complementary to the effective increase in absorbing power of the crystal for rays which meet the atomic planes at the selective reflexion angles, and it varies for different planes according to the degree of multiple reflexion that can take place, that is, according to the degree of parallelism of individual crystallites.

By studying the absorbing power of the crystal at the Bragg angles, therefore, it is possible to obtain useful information about the crystallite arrangement. The white lines on a grey background observed when a divergent X-ray beam is transmitted through a single crystal[9] are, in fact, a record of this selective absorption at the Bragg angles, and crystals of different texture are found to give patterns which, though geometrically equivalent, are of very different quality. Really perfect crystals give no pattern, since their reflecting power is so very small. It has been rather surprisingly found that even organic compounds sometimes grow as perfect crystals, which give no divergent beam pattern until they are broken up into crystallites by sudden immersion in liquid air. Ice also forms very regular crystals even at temperatures only a little below 0° C., when the thermal vibrations are exceptionally strong. Using coarse-grained film, divergent beam patterns can be obtained with exposures of only a few seconds at, say, 5 cm. crystal to film distance; but the crystals must not be so thin that their reflecting power is small, or so thick that complete absorption occurs at all angles. The optimum thickness for diamond, ice or organic compounds, using radiation from a copper target, is about 1 or 2 mm. Patterns can only be obtained from crystals of high atomic weight if short-wave radiation is used.

Some of the difference in texture between different diamonds may be due to the presence of foreign atoms. Silicon, aluminium, calcium and various other atoms of relatively high atomic weight are known to occur in diamond, and it is quite likely that hydrogen, boron and nitrogen may also be present. It was of interest to find out whether these would produce any change in the lattice constant of individual diamonds. The divergent beam method provided an excellent method of investigation, for photographs could be taken at long distances without impossibly long exposures, and the positions of certain points of intersection of the absorption lines on the films were extremely sensitive to small changes in λ/a. The wave-length, λ, being accurately known for copper $K\alpha_1$ radiation, the lattice constant a could be determined with an accuracy of about 1 in 70,000. It was in fact found that four different diamonds studied had values of a varying between the limits 3·56000 and 3·55942 kX., corresponding to a C—C distance of 1·54153–1·54127 kX. (or 1·54465–1·54440 A.). All precision measurements made in other laboratories, whether for single diamonds or for diamond powder, fall within these limits.

[1] Lonsdale, K., Reports on Progress in Physics (1942–43), **9**, 256, for collected references to experimental work.

[2] Born, M., Reports on Progress in Physics (1942–43), **9**, 294, for collected references to theoretical work.

[3] Müller, A., *Proc. Roy. Soc.*, A, **174**, 137 (1940); A, **178**, 227 (1941).

[4] Lonsdale, K., Robertson, J. M., and Woodward, I., *Proc. Roy. Soc.*, A, **178**, 43 (1941). Knaggs, I. E., and Lonsdale, K., *J. Chem. Soc.*, 417 (1942).

[5] Robertson, J. M., and Woodward, I., *J. Chem. Soc.*, 36 (1940). Ubbelohde, A. R., and Woodward, I., *Proc. Roy. Soc.*, A, **181**, 415 (1943).

[6] Ubbelohde, A. R., and Woodward, I., *Nature*, **155**, 170 (1945) *Proc. Roy. Soc.*, in the press.

[7] Ubbelohde, A. R., and Woodward, I., *Nature*, **156**, 20 (1945).

[8] Lonsdale, K., *Mineral. Mag.*, **27**, 112 (1945).

[9] Lonsdale, K., *Nature*, **151**, 52 (1943); **153**, 22, 433 (1944); *Phil. Trans. Roy. Soc.*, in the press.

INDUSTRIAL DERMATITIS

INDUSTRIAL dermatitis is a special branch of a specialized subject. It receives little attention in the systematic teaching of medicine, and is considered with diffidence by the general practitioner because of its medico-legal implications. Its proper study is confined largely to the dermatologists and to those physicians employed in industrial medicine.

The clinical manifestations of industrial dermatitis are often indistinguishable from those of eczema, and accurate diagnosis is a matter involving special experience as well as dermatological skill. Occupational dermatitis is not confined to artisans. It can be found in all walks of life, as for example in dentists, who may produce a dermatitis due to local anæsthetic solutions, or in medical practitioners, who may be sensitive to certain antiseptics.

Investigation of any case of dermatitis must be very thorough and include inquiry into all the patient's activities at work and in leisure, as the cause of dermatitis may lie not only in the substances of industry but also in things encountered in the home or garden. Psychological factors in the production of skin diseases are gradually being brought to light, and when this subject is better understood it will probably be possible further to classify the types of dermatitis.

The number of substances known to cause dermatitis grows in proportion to the rate of introduction of new processes in industry, and the war years

have added much to our knowledge. Already cases of dermatitis caused by penicillin solution have been reported as occurring in medical men and others handling it. Unfortunately the growth of our knowledge is mainly of theoretical value, and progress in prevention and in therapeutics is not so marked.

The large number of cases of industrial dermatitis and the inadequacy of dermatological facilities at the present time make it necessary for the long-suffering general practitioner to undertake, in most cases, if not the diagnostic procedures, at least the after-care of such patients.

Dr. Archibald Gray's survey* of the social aspects of industrial dermatitis is of the greatest value in illustrating some points which are not apparent to the average general practitioner who may see only a few cases each year, and which are not to be found in the standard text-books on skin diseases. He points out that the terms, 'industrial dermatitis' and 'occupational dermatitis', are not synonymous, and that industrial dermatitis defines those cases of occupational dermatitis occurring in persons coming under the Workmen's Compensation Act and described officially as 'dermatitis produced by dust or liquids'. Thus the domestic servant with dermatitis due to excessive use of soap and water can claim compensation and is a case of industrial dermatitis, while her mistress, who might equally suffer from a similar condition, would rank as a case of occupational dermatitis.

Industrial diseases of the skin, apart from 'dermatitis produced by dust or liquids', include (1) ulceration due to dust or liquids; (2) epitheliomatous cancer or ulceration due to tar, pitch, bitumen, mineral oil or any compound, product or residue of any of these substances; (3) chrome ulceration or its sequelæ; (4) scrotal epithelioma (chimney-sweeps' cancer); (5) inflammation, ulceration or malignant disease of the skin or subcutaneous tissues due to exposure to X-rays or radioactive substances.

Industrial dermatitis differs from other industrial diseases in that it can be produced by a great variety of agents; but the eruption so produced gives no clue to the actual agent involved, save that a follicular inflammation suggests tar, oil or chlorinated naphthalene. The incidence of industrial dermatitis is not accurately known; but Dr. Gray suggests, not without reason, that if the manpower loss could be computed it would be a startling figure.

Most cases of industrial dermatitis are associated with damage to the horn layer of the skin. The irritating substances penetrate this layer, damage the cells from which it is formed, and by thus interfering with its production, further increase the liability to trauma. The protective power of the horn layer is naturally lower in individuals whose oil glands are underactive. The more actual irritants are mostly met with in special trades, and factory surgeons and H.M. inspectors of factories are usually quick to recognize irritant properties in new substances used in industry, and to find ways of eliminating or reducing the risks incurred. A large group of cases caused by common irritants, such as soap, soda and water, lime and cement, etc., are impossible of control. The fact that the majority of handlers of potentially irritating substances escape dermatitis requires explanation and raises the subject of relative sensitivity. Hebra showed long ago that certain irritants, if left long enough in contact with normal skin, would produce eczematous dermatitis. The determining factors are the intensity of the irritant and the time of exposure. Dermatitis may arise in the normal skin from mild irritants if cleansing is imperfect or if impregnated clothes are constantly worn. Cleansing substances themselves (for example, turpentine used to remove grease from the skin) may cause dermatitis. In other cases the skin is not normally resistant. Rarely there is sensitivity to one specific substance, and the best example is of the gardener who is sensitive to *Primula obconica*. A common factor in those two groups is that removal of the irritant is followed by healing of the disease. In the first group, the individual can return to work, usually without danger, provided he washes properly and changes his clothes after work. Those in the second group, with an individual sensitivity, must avoid contact with the known irritant, but can otherwise do ordinary work.

This is not so in most cases of eczematous dermatitis where removal of the man from work is not at once followed by healing and where, indeed, spread or new lesions may occur after all exposure to the irritant has ceased. Most of these cases are in men over forty, many of whom have been in the same trade for years. Idiopathic eczema often occurs at this age, and MacCormac's opinion is that "many cases of alleged occupational eczema about this age are probably idiopathic eczema or alternatively examples of idiopathic eczema prematurely induced by the occupation, but maintained by the diathesis which determines eczema". These people show a loss of skin resistance due to age and unknown factors, possibly vascular or metabolic. This is borne out by the fact that after the original attack has cleared, return to work which occasions exposure to any irritant, not necessarily the one which caused the first attack, will almost certainly cause a recurrence.

Compensation under the Workman's Compensation Act is payable if the area examining surgeon, appointed by the Ministry of Labour, decides that dermatitis is due to a man's work; but employers have a right of appeal to a medical referee, whose decision is final. There is usually no delay in settlement, save when the workman is ignorant of procedure or when legal difficulties arise in deciding who shall pay compensation when a man has had more than one employer within the previous year.

Failure to respond to treatment has in some cases a profound psychological effect on the sufferer, as, for example, when a skilled worker is not sure whether he can return to his own trade. If this is to be closed to him it may mean a reduction in wages should he have to return to the ranks of unskilled labour. The fate of those certified as suffering from industrial dermatitis is thus classified by Dr. Gray: (1) some cases respond readily to treatment and can return to work if they take reasonable precautions; (2) others respond to treatment, and, though they cannot return to their original employment, can find work in other trades; (3) a last group includes cases who do not readily respond to treatment and whose condition is complicated by an anxiety neurosis which keeps up the skin condition and makes them unfit for work of any kind for a long period.

Preventive measures in industry are comprehensive and include proper ventilation and lighting of works, mechanical removal of dusts, protective clothing, provision of adequate washing facilities, the use of

* "Some Social Aspects of Industrial Dermatitis." The Malcolm Morris Memorial Lecture, delivered at the Westminster Hospital Medical School on November 29, 1945, by Dr. Archibald M. H. Gray, under the auspices of the Chadwick Trust.

barrier creams, etc. Some people, especially liable to dermatitis (for example, sufferers from eczema, people with very dry skins, etc.), can be weeded out in advance and prevented from undertaking employment which, for them, is hazardous. Skin tests can, in rare cases, be used to find susceptible individuals.

The treatment of established dermatitis falls usually to the general practitioner, and Dr. Gray regrets the fact that the teaching of dermatology to medical students at the present time is inadequate and that often attendances at skin clinics are perfunctory. Should the general practitioner wish to send his patient to a consultant, this is often difficult and involves delay. Mental and physical rest are the first essentials of treatment, and these are only attainable in hospital. The number of hospital beds at present available for cases of skin disease is grossly inadequate. Much could be done to reduce time lost by sufferers from dermatitis if there were good facilities for out-patient and in-patient hospital treatment and for the rehabilitation of patients in the period after leaving hospital and before they are fit to resume work. Part of the problem of anxiety would be solved if the workman's financial worries could be allayed by an assurance that compensation would not be delayed and would continue as long as he remained incapable of full employment.

Dr. Gray ends on a plea for increased facilities for dermatological research and outlines his conception of the problems to be studied. J. MARSHALL.

GEOLOGY OF THE SALT RANGE OF THE PUNJAB

THE Salt Range of the Punjab runs with arcuate plan for some hundred miles eastward from the Indus. Along its southern front it overlooks a sector of the great Indo-Gangetic alluvial plain, here standing about 800 ft. above sea-level. Its mountain summits often rise well above 2,000 ft., and one of them only just fails to reach 5,000 ft. The following geological formations at one place or another enter into its constitution :—

Pliocene to Miocene. Siwaliks above Murees : a non-marine assemblage.

Middle and Lower Eocene. ? Punjab Saline Series ? above Lakis and Ranikots : frequently foraminiferal.

(unconformity).

Cretaceous and Upper Jurassic.

(unconformity).

Lower Jurassic, Trias, Permian and Upper Carboniferous. With Talchir glacial boulder bed at base.

(unconformity).

Cambrian. Salt-pseudomorph beds above magnesian sandstones, Neobolus shales and purple sandstone ; the last-named, being unfossiliferous, may perhaps be pre-Cambrian.

(contact variously interpreted).

Pre-Purple-Sandstone. ? Punjab Saline Series ?

The geological structure of the Salt Range is complicated, and before 1943 such few fossils as had been obtained from the Saline Series had all been challenged as introduced material. Accordingly, it was possible for a controversy to linger on from 1903 as to whether the Saline Series was of pre-purple-sandstone or of Eocene date, a truly amazing difference of opinion fraught with big consequences. Readers of the correspondence columns of *Nature* during 1944–45 will have realized that the debate has recently flared up with renewed vigour[1]. The cause has been an unexpected discovery by B. Sahni, whose reputation as a botanist is world-wide, that the Punjab Saline Series contains myriads of minute plant fragments of types that cannot be older than mid-Mesozoic. The matter has been handled admirably. A party of experienced field geologists has visited critical exposures, and a symposium has been called and its deliberations published[2]. Unfortunately, the two antagonistic theses indicated above are still maintained, and an onlooker finds himself in the predicament so well expressed in "The Beggar's Opera" : "How happy could I be with either, if t'other dear charmer were away".

In a short review it is only possible to outline the new evidence, which Sahni accepts at face value, and the nature of the response which it has evoked from E. R. Gee and others, who are not prepared to follow suit. References inserted below are to pages in the published account of the symposium.

Sahni claims that his fossil specks, of which the largest shown in his present illustrations only measures 0·5 mm., should be ascribed to wind-borne dust contemporaneous with the precipitation of the salt (p. xxv). He has established a wide distribution in specimens collected in mines sixty miles apart along the outcrop (p. ii). One location illustrated in a photograph is recorded as 730 ft. below surface and 4,150 ft. from mine entrance (p. xxxii). The organic matter is found in material which seems to have retained unblurred bedding. It is present alike in rock salt, saline earth, dolomite and oil shale (p. ii and photos p. xxxii). It occurs not only in specimens collected by Sahni and his party, but also in others collected by Gee and his party (p. xii). It shows in thin sections as well as on surfaces exposed by solution (p. ii). Great care has been taken to avoid laboratory contamination (p. viii). At the symposium a 'block' of dolomite "under ·5 cc. in size was cut out of the interior of the hand specimen and polished on all faces to show that it was not cracked or pitted. It was rotated in a gas flame before it was placed in a jar of dilute HCl. After a few minutes a small piece of carbonized wood was released from the rock" (p. 313). All except one of the specimens which Sahni has investigated have yielded organic micro-debris, chiefly wood of angiosperms or gymnosperms, grass-like cuticles, pollen grains and chitinous parts of insects (p. viii). Attempts to discredit this material on the ground that it is more recent than Eocene are rebutted with the answer that there is nothing in its nature to show that it is later than mid-Mesozoic (pp. xxvii, 325) ; the fresh condition of much of it may be ascribed to embalment (p. x).

A. Lahiri, in a contribution (p. 329) which serves as a valuable supplement to Sahni's own, publishes photomicrographs of organic micro-debris still embedded in oil shales, some of the latter universally admitted to belong to the Punjab Saline Series. He says of certain samples that "the organic matter is found to be mostly in the form of minute fragments (perfectly laminated with the plane of bedding of the rock) of carbonized wood, fossil microspores, cuticles and pollen grains, only recognizable under high power and after the separation of the mineral matter".

E. R. Gee has given a wide and altogether admirable account of the subject, furnished with geological maps which can usefully be treated as illustrations of the report as a whole. Gee some years ago accepted the Eocene dating of the Punjab Saline Series, but by 1939 he had seen reason to change his mind

(pp. 295–305). Accordingly, on publication of Sahni's discovery, he got J. Coates, H. Crookshank, P. K. Ghosh, E. Lehner and E. S. Pinfold, geologists of oil companies or of the Geological Survey of India, to check with him a number of critical exposures. The verdict was unanimous (p. 306):

"The junction of the Saline series and the overlying purple sandstones (Cambrian or older) is in several sections conformable and transitional. This is well seen in exposures east of the Warcha Circuit House.

"The junction of the Upper Carboniferous Talchir Boulder bed with various stages of the Cambrian and the Saline series was examined over several miles of its outcrop south of Sakesar. Here also our opinion is that this junction is normally an ordinary sedimentary overlap, thus precluding an age for the Saline series later than Talchir.

"Regarding the evidence of Tertiary to sub-Recent fossils found by Prof. Sahni, we observed so many instances, even deep in the salt mines, of sub-Recent material being enveloped in the salt and in the marls that it seems possible Prof. Sahni's fossils had a similar origin notwithstanding that in many cases they have every appearance of being *in situ*. Our conclusions were arrived at despite the recognition of certain difficulties, such as the occurrence of minute plant fragments of post-Cambrian age in the dolomites and oil-shales, for which at present we have no clear explanation to offer."

Gee himself suggests introduction of comparatively recent plant debris along joint planes of the oil shales (p. 308); but it seems at first sight difficult to reconcile this interpretation with Lahiri's photomicrographs mentioned above.

The other eleven authors who have contributed written reports to the symposium have all interesting comments to make; but none can claim to have settled the matter at issue to everyone's satisfaction.

The reviewer has not yet heard the outcome of a second symposium called for December 1945.

E. B. BAILEY.

[1] *Nature*, 153, 462, 654 (1944); 154, 53, 54 (1944); 155, 76, 266, 580; also, as separate paper, 155, 258 (1945).

[2] Symposium on the Age of the Saline Series of the Punjab, *Proc. Nat. Acad. Sci. India*, 14, Pt. 6, i–xxxii, 205–334, 9 plates, 29 text-figures. Price, including postage, Rs. 4/8 (India), Rs. 5 (Foreign).

COLLECTIONS OF MICRO-ORGANISMS

AT the meeting of the Society for General Microbiology held at the London School of Hygiene and Tropical Medicine during December 19–20, an afternoon session was devoted to a symposium on the "Role, Organisation and Maintenance of Collections of Living Micro-organisms". The Committee of the Society was fortunate in being able to arrange, through the good offices of the British Council, for Prof. Johanna Westerdijk, director of the Centraalbureau voor Schimmelcultures, Baarn, Holland, and Prof. A. J. Kluyver, director of the Laboratorium voor Microbiologie at the Technische Hoogeschool, Delft, Holland, to take part in the meeting and in this way renew with British men of science contacts that had been broken by war. From an analysis of the papers submitted and of the subsequent discussion it appeared that the sense of the meeting was in accord with a principle implicit in the constitution of the Society, namely, to promote the co-ordination of microbiology in its various disciplines and at its different levels; the development and maintenance of generalized collections of micro-organisms being ancillary to this purpose.

Prof. Westerdijk, in opening the symposium, gave an account of the development of the collection under her charge at Baarn, which was started in 1906 by Prof. Went of Utrecht with a collection of fungi from Java as a nucleus. It passed into her hands in the following year and had made uninterrupted progress up to the time of the Second World War, when it comprised some seven thousand strains of fungi. In surveying the ground covered by type collections, Prof. Westerdijk emphasized the importance of the choice of media in fungal conservation and of the necessity for using vegetable substrates containing essential growth factors. About eighty different media were in present use at Baarn, with varying carbohydrate content. She thought that such diversity was quite essential for successful cultivation; but that in order to maintain typical forms, changes in temperature and light were equally necessary. Prof. Westerdijk described herself as a "botanist-keeper of a fungus garden" and admitted her preference for typical growths as distinct from crippled and reduced forms. There is much to be said for this point of view, though the method of spore-conservation in lyophile form, now under trial in the United States and elsewhere, promises to be of the utmost value to mycologists in maintaining strains in an unaltered condition with the greatest economy of effort.

As the kind of material that should be conserved, Prof. Westerdijk thought that collections of micro-fungi should include botanical species and varieties and strains with different morphological, cultural, parasitic or physiological characters. With regard to the question as to whether collections should contain guaranteed or merely preserved specimens, this depended on the type of workers employed and on the equipment and amenities provided; as in so many other spheres of human activity, financial considerations tend to be the limiting factor. Collections maintained on a proper basis should provide facilities for research workers and should be fortified through international co-operation and reciprocity—this notwithstanding the difficulties of the times with their profound and hard antagonisms. The theme of international co-operation was developed and extended by Dr. R. St. John-Brooks, curator of the National Collection of Type Cultures of Micro-organisms, in a subsequent communication.

Prof. Kluyver prefaced his remarks with the question "What is the use of a collection of living micro-organisms?" In his opinion the answer was that such collections, provided they bore a truly international character, formed a most useful and, indeed, a more or less indispensable basis for the better foundation of the classification of certain groups. He gave an account of the yeast collection at Delft, which, as a subdivision of the Centraalbureau voor Schimmelcultures, had in its development brought together a more or less representative series of yeast strains contributed by experts from a world-wide field, thus providing special facilities for the systematic and taxonomic revision of the group of micro-organisms in question, including both ascosporogenic and anascosporogenic forms. Such studies had indeed been undertaken in his laboratory by members of his staff and had been published in three volumes, which had appeared between the years 1929 and 1942. He hoped that these publications would

help to facilitate the identification of newly isolated yeasts by others and so avoid the erection of unjustifiable species. The Delft collection, which now embraced about 1,200 strains representing some four hundred different species, provided a centre where such identifications could be made; but, Prof. Kluyver pointed out, the principal function of the collection would remain in the supply of reliable cultures for purposes of comparative study and of fundamental research. It could not be sufficiently stressed that the success of such an undertaking depended on the fullest measure of international co-operation, which, moreover, facilitated the maintenance of duplicate cultures in different institutions and thus reduced to a minimum the hazard of neglect or loss.

In his paper "Some Functions of a Bacterial Collection in Serology", Mr. H. Proom, of the Wellcome Physiological Research Laboratories, stressed the importance of a representative collection of micro-organisms as an essential precursor of the study by teams of biochemists, physiologists and biologists of the innumerable facets of microbiology. He pointed out that since the advances in this field were completely unpredictable, it was essential that little-studied and immediately unimportant groups should receive special consideration, since other groups of more immediate interest would, presumably, receive the attention of those especially concerned. Mr. Proom put forward a plea for the establishment of an institute of microbiology, which a subsequent speaker, Dr. E. G. Pringsheim, curator of the Type Collection of Algæ at the Botany School, Cambridge, elaborated in some detail. As a temporary measure Mr. Proom suggested the establishment of specialized collections of micro-organisms in selected institutions, co-ordinated by the curator of a central collection. The collection in his charge at Beckenham was maintained almost entirely as desiccates, and he gave the meeting an account of his experiences in the maintenance of cultures by means of drying from the frozen state. He discussed the physical factors which influenced death during and after desiccation and the need for their more complete and quantitative investigation. Since dried cultures showed no metabolic change, strains could be dried in their optimal metabolic state and maintained as the particular variant required. This was of considerable importance in the production of high-value toxin and the comparison of the drug sensitivity of strains isolated over a period; in fact, in any research that might be complicated by bacterial variation.

Dr. Pringsheim took up the theme of the proposed institute of microbiology and said that provision should be made for the conservation and study not only of bacteria and fungi of pragmatic importance but also of all kinds of minute organisms, such as free-living ciliates, flagellates and algæ, unbiased by immediate practical aims. The Institute should be organised to safeguard continuity and the preservation of type cultures, and should engage in such research as was necessary for improving cultural technique and for the identification of species. Dr. Pringsheim's conception of a central institute for general microbiology has been embodied by him in a detailed plan for its foundation, which he has placed in the hands of the secretaries of the Society.

A subject of much interest was discussed by Prof. J. F. D. Shrewsbury, Department of Bacteriology, University of Birmingham, in connexion with a proposed collection of photomicrographs and photographs of microbiological material. He thought that the time had come to begin such a collection on a national basis in order to provide present and future workers in microbiology with a permanent and, he believed, a much-needed reference collection. He suggested that when, under proper copyright safeguards, a photograph had been lent to and accepted by the collection, a positive and negative contact print should be made from it and the original returned to its owner. The negative prints or plates would then be documented and placed in a master file, while the positive prints would be deposited in a working file from which negative contact prints could be made for dispatch to applicants. At first the collection would have to be a charge on the funds of the Society; but once established, should be self-supporting through charges made to cover expenses. He suggested that such a scheme should be under the supervision and control of a curator and should be sponsored by the Society.

In the course of his remarks on "International Aspects of Type Culture Collections", Dr. St. John-Brooks suggested that, in order to promote international co-operation and integration in respect of the development of type culture research institutes, an international commission or an international advisory committee should be formed. It might appropriately be sponsored by the International Association of Microbiologists, and the international character of such an organisation might be developed through the national research councils in the various countries concerned and through their local microbiological societies—such as the (British) Society for General Microbiology. The utmost reciprocity should exist among the various institutes, with facilities by means of a central international bureau for exchange of cultures and research publications. The ever-increasing extent and rapidity of air mail connexions would make such liaison more and more possible and thus encourage specialization of function and obviate unnecessary overlapping in the conservation of material.

In the course of the discussion which ensued, in which Dr. Paul Fildes, Major J. E. McCartney and others took part, Dr. C. H. Andrewes, National Institute for Medical Research, said that for the purposes of a national collection it was both impracticable and undesirable to separate the different branches of microbiology. Whatever temporary arrangement might be expedient and necessary, the objective should be a collection catering not only for medical, veterinary, agricultural and industrial interests, but also for 'pure' microbiology. The collection should be so organised that the members of the staff were sufficiently numerous to carry out its functions with complete efficiency and yet were able to devote a reasonable time to research, of which at least some should be in the field of taxonomy. In order to combine perfection of performance with economy of effort, cultures of several categories should be maintained. One, consisting of those most in demand, should have the nature and properties of the strains concerned guaranteed by the staff. Others of limited and specialized interest, deposited by correspondents and passed on to applicants, need have no guarantee other than that of the worker supplying the culture. Most cultures in this category could probably be kept in dried form or at −76° C. and would rarely need subcultivation. This would especially apply in the case of deposited strains of viruses.

OBITUARIES

Prof. Charles Fabry, For.Mem.R.S.

Marie Paul Auguste Charles Fabry was born at Marseilles on June 11, 1867, into a family of scientific outlook. His grandfather had been a pupil of Ampère, and two elder brothers were *correspondants* of the Academy of Sciences, Eugène in geometry, Louis in astronomy. A brilliant career at the École Polytechnique led to a doctorate in physical sciences in 1892; his thesis showed the line which he was to develop so successfully, its title being "Théorie de la visibilité et de l'orientation des franges d'interférence". In 1894, he returned to Marseilles to lecture on physics under Macé de Lépinay, whom he succeeded as professor ten years later. At Marseilles he had as colleague successively Perot and Buisson, with both of whom he collaborated in a number of important papers on interferometry and spectroscopy. Although his researches were mainly in the field of optics, locally he was best known as a most successful teacher of electrotechnics: he gave a weekly lecture on Wednesday evenings to an overflowing audience of students, engineers and workpeople.

The War of 1914–18 took Fabry away from his beloved Marseilles for radiographic work, later as a scientific adviser to the Artillery and then as head of a scientific mission to the United States. By that time his international position in the world of science was already fully established, and he was received with open arms—and open doors. Meanwhile, de Gramont and Chrétien, with the fullest support of Painlevé, had been preparing for the foundation of an optical institute which should combine exact measurements of optical instruments and constants with a workshop where men could be trained for all types of work required by the optical industry. Fabry was the obvious man for the post of director to which he was called in 1920, becoming at the same time professor of physics at the Sorbonne with Prof. Cotton as his colleague. There, until his retirement in 1937, he built up by his teaching the optical industry of France and schools of research in optical principles and practice which secured brilliant results from his pupils in such allied fields as astrophysics.

On his seventieth birthday his colleagues, the National Fund for Scientific Research and the publishers Gauthier-Villars joined in a scheme for the publication of his collected papers, and in considering the great volume of his scientific output we have the advantage of his mature judgment in selecting the most important work. Interferometry comes first, and we have accounts of the Fabry–Perot interferometer, measures of standard wave-lengths in the laboratory and the sun (work of fundamental importance for the astrophysicist), general studies of the effects to be obtained by the use of thin silver films, absolute measures in electricity, new principles for colour photometry, photometric measures of the sun, the corona, the night sky and a study of the distribution of radiation in the ultra-violet spectrum of the sun, the effect of the ozone layer on atmospheric absorption. One of the memoirs of special interest to us to-day is his own account of "L'Institut d'Optique", published in 1928 in the *Revue internationale de l'Enseignement*. Among his more popular addresses, not included in his collected papers, mention may be made of "La photométrie astronomique et celle des physiciens" in the *Annuaire du Bureau des Longitudes*, 1936, his Thomas Young Oration to the Physical Society in 1936 on "Vision in Optical Instruments", and his George Darwin Lecture to the Royal Astronomical Society in 1938 on "Interstellar Space".

Fabry's activities in international scientific circles were numerous and distinguished: starting with contributions in 1904 on standard wave-lengths to the International Union for Solar Research, he served on the wave-lengths committee of the Union (and later on that of the International Astronomical Union) for forty years. He also served on the Committee on Instruments of the International Astronomical Union from its formation, being president during 1928–38 and later its président d'honneur. He served on committees of the International Astronomical Union on nebulæ, stellar photometry and spectrophotometry and on a committee of the International Council of Scientific Unions on Solar and Terrestrial Relationships. He was vice-president of the International Astronomical Union during 1932–35 and 1938–45, and president of the International Council of Scientific Unions during 1937–45. His sound judgment, charm of manner, lucidity and humour endeared him to his colleagues both at home and abroad. He received in 1918 the Rumford Medal of the Royal Society, of which he became a foreign member in 1931; he became an associate of the Royal Astronomical Society in 1915; he received the Franklin Medal of the Franklin Institute in 1921, and the Draper Medal of the National Academy of Sciences in 1919. He died in Paris on December 11, 1945, after some months of suffering.

F. J. M. Stratton.

Prof. F. R. Immer

We regret to announce the death, on February 2, at the age of forty-six, of Prof. F. R. Immer, distinguished as a plant breeder, who had been associate director since 1941 of the University of Minnesota Agricultural Experiment Station at St. Paul.

Although most of his life had been spent in genetical research, with special reference to statistical methods, the design of field experiments and research in plant disease, Prof. Immer visited England in 1944 for special duty as operations analyst with the Eighth Air Force, where he served with distinction in the analysis of bombing operations and the improvement of bombing accuracy. It was only shortly before his death, therefore, that he returned to the United States as chairman of the North Central Regional Directors, Farm Structures Committee, of the Association of Land Grant Colleges Committee on Farm Structures Legislative Bill and of the North Central Regional Directors, Poultry Breeding Committee, and member of the crops section of the American Society of Agronomy.

As a fellow of the National Research Council, Prof. Immer visited England and Sweden in 1930–31, studying statistics at Rothamsted Experimental Station and plant breeding at Svalof.

The fruits of Prof. Immer's research consist partly in improved crop varieties, particularly with regard to disease resistance, quality and yield, and partly in improved methods in the technique of plant breeding. In 1942 he published jointly with H. K. Hayes the standard text-book, "Methods of Plant Breeding".

ROYAL SOCIETY ELECTIONS

THE Council of the Royal Society is submitting the following for election on March 21 as fellows of the Society:

DR. AGNES ARBER, of Cambridge, distinguished for her outstanding contributions to the elucidation of the morphology of flowering plants, especially the monocotyledons.

PROF WILSON BAKER, professor of organic chemistry, University of Bristol, distinguished particularly for structural work relating to the natural colouring matters, and for important contributions to the theory of chelate compounds in the aromatic series.

G. L. BROWN, medical member of the staff of the Medical Research Council, distinguished for his investigations in the chemical transmission of nerve impulses through sympathetic ganglia, and from nerve to skeletal muscle.

PROF. G. R. CAMERON, professor of pathology, University College Hospital, London, who has made distinguished contributions to our knowledge of changes produced in the liver and other organs by operative procedures and by toxic chemicals.

DR. F. DICKENS, director of research of the North of England Branch of the British Empire Cancer Campaign, distinguished for ingenious improvements in manometric methods, and for investigations of the metabolism of animal tissues, especially in relation to tumours.

DR. H. J. EMELÉUS, reader in inorganic chemistry, University of Cambridge, distinguished for his researches in modern inorganic chemistry, in particular the compounds of silicon and of fluorine.

SIR FRANK ENGLEDOW, professor of agriculture, University of Cambridge, and director of the Imperial Bureau of Genetics, distinguished for his great assistance in maintaining and raising the standard of scientific development in agriculture both at home and in the Colonies.

DR. E. B. FORD, reader in genetics, University demonstrator in the Department of Zoology and Comparative Anatomy, Oxford, distinguished for his experimental researches in genetics and the elucidation of ecological and evolutionary situations.

DR. R. A. FRAZER, of the National Physical Laboratory, distinguished for his work on aeronautics, particularly on problems of flutter, combining mathematical work with great experimental skill and ingenuity.

C. D. GIBB, director-general of armoured fighting vehicles, chief engineer and joint managing director of Messrs. C. A. Parsons and Co., Ltd., distinguished for original research and design and for introduction of new methods of manufacture in connexion with steam turbines; also for work of great national importance on various types of armament in the War.

DR. E. A. GUGGENHEIM, lecturer in chemical thermodynamics, Imperial College of Science and Technology, London, distinguished for his authoritative contributions to thermodynamics and statistical mechanics.

R. HILL, member of staff of the Agricultural Research Council (Cambridge), distinguished for his researches in hæmoglobin and tetrapyrrolic compounds, and upon the photochemical production of oxygen by isolated chloroplasts; the latter has opened up a new biochemical approach.

DR. ERNEST MARSDEN, distinguished for his earlier work on radioactivity, including the scattering of α-particles by the nucleus, and later as director of scientific developments in New Zealand, where he has been largely responsible for the direction of the Dominion's scientific work in both peace and war.

DR. W. G. PENNEY, assistant professor of mathematics, Imperial College of Science and Technology, London, distinguished for his theoretical investigations on molecular structure and related subjects; during the War he has made valuable contributions to the understanding of explosion waves.

PROF. J. T. RANDALL, professor of physics, University of St. Andrews, distinguished both for his researches on the luminescence of solids and liquids and for his outstanding contributions to the generation of high-frequency radio waves.

DR. R. O. REDMAN, chief assistant at the Radcliffe Observatory, Pretoria, distinguished for his many contributions to observational astronomy and astrophysics.

PROF. A. R. RICHARDSON, of Cape Town, formerly professor of mathematics at University College, Swansea, distinguished for his researches in algebra, including non-associative algebras, generalized determinants and group characters.

PROF. L. ROSENHEAD, professor of applied mathematics, University of Liverpool, distinguished for his researches in hydrodynamics and aerodynamics, which have contributed to the fuller understanding of vortex motion; during the War he led a team of mathematicians working on rocket projectiles.

BRIGADIER J. A. SINTON, V.C., consultant malariologist to the War Office; as director of the Malaria Survey of India during nine years, he contributed greatly to the knowledge of all aspects of malaria.

DR. H. H. STOREY, of Nairobi, plant pathologist, one of the foremost workers on virus diseases of plants, who has made noteworthy investigations on the role of insect-vectors in the transmission of such diseases.

DR. H. W. THOMPSON, University demonstrator in chemistry, Oxford, distinguished for his researches on the application of spectroscopic methods to chemical problems, in particular the development of infra-red technique.

J. W. TREVAN, director of the Wellcome Physiological Laboratories, distinguished for numerous researches in pharmacology, and especially for his contributions to methods of biological assay and to the 'error of determination of toxicity'.

PROF. L. R. WAGER, professor of geology, University of Durham, distinguished for his contributions to petrology, particularly for his work in East Greenland, in Ireland and in the Himalayas.

DR. F. M. R. WALSHE, physician to the National Hospital, Queen Square, London, editor of *Brain*, distinguished for his physiological studies on the human nervous system by clinical investigations.

PROF. C. M. YONGE, regius professor of zoology, University of Glasgow, distinguished as an invertebrate zoologist, more particularly in the field of the Mollusca; as leader of the Great Barrier Reef Expedition, he was responsible for the organisation of the work and for his own studies on corals.

NEWS and VIEWS

Metrology at the National Physical Laboratory: Mr. J. E. Sears, C.B.E.

MR. J. E. SEARS is retiring on March 31 from the superintendentship of the Metrology Division of the National Physical Laboratory, of which Division he has had charge since 1910. His pioneer work and the contributions he has made to the science and art of metrology are outstanding and have won for him a unique place among scientific workers. The important position which metrology occupies to-day in the field of applied science is, in great measure, due to his efforts. An appreciation of the wide range of Mr. Sears' activities may be gathered from the scope of the work of his Division which, while primarily responsible for maintaining standards for, and advancing the technique of measurement of, the fundamental quantities length, mass and time, and the more immediate derivatives area, volume, density, pressure, etc., deals also with the industrial applications of such measurement. The Division is concerned with the design and development, as well as the inspection, of engineers' gauges and precision measuring instruments, gears and hobs, balances and weights, watches and chronometers, volumetric glassware, hydrometers and barometers—even now the list is incomplete. Mr. Sears' flair for designing is shown in the wide variety of measuring instruments and machines developed and constructed in the Division—screw-measuring machines and optical projectors, a primary standard barometer of unique design and a knife-edge balance of exceptionally high accuracy, to cite a few contrasted examples. Under his leadership, many researches of fundamental importance have been carried out; reference may be made to a determination of the yard and the metre in terms of wave-lengths of light, of the refractive index of air, and of the absolute value of gravity at the National Physical Laboratory.

During the First World War, Mr. Sears rendered invaluable assistance to the Ministry of Munitions by undertaking, within his Division, the inspection of the limit gauges required by the Service departments, a task which necessitated a very large expansion of the gauge-testing section of the Division. For this work he was awarded the C.B.E. Mr. Sears rendered similar service in the Second World War. His experience of standards and standardization is unparalleled and his services on numerous committees, including those of the British Standards Institution, have been continually in demand. During 1921–32, Mr. Sears was Deputy Warden of the Standards, in which capacity he had charge of the Standards Department of the Board of Trade. Since 1930, he has served as the British representative on the Comité International des Poids et Mesures. He will continue to serve on this Committee, of which he is now acting president.

Mr. F. H. Rolt, O.B.E.

MR. F. H. ROLT has been appointed to succeed Mr. J. E. Sears. Mr. Rolt was born on November 1, 1888, and educated at Rutlish School, from which he obtained a Surrey County Council major scholarship to the City and Guilds Institute, London, where he obtained the diploma in civil and mechanical engineering, afterwards obtaining his degree in science at the University of London as an external student. On leaving college he spent several years gaining practical experience at various engineering works, including Messrs. Cairds, Greenock; Fairfield Shipbuilding Co., Greenock; and Babcock and Wilcox, Ltd., London office. He joined the staff of the National Physical Laboratory, Metrology Division, in 1912. During the First World War, he was associated with the gauge-testing work carried out at the Laboratory for the Ministry of Munitions, and for his services in that connexion was awarded the M.B.E. His subsequent activities in the same field and his work "Gauges and Fine Measurements" have won him an international reputation as a metrologist. In 1941 he was loaned by the Laboratory to the Ministry of Supply, where he acted first as director of gauges and measuring instruments and eventually as director of jigs, tools and gauges. For these services he was recently awarded the O.B.E.

Prof. T. G. Hill

THE title of professor emeritus bestowed on Prof. T. G. Hill, who recently retired from the professorship of plant physiology at University College, London, will give satisfaction to a wide circle of friends and colleagues. Prof. Hill's retirement takes from the councils of the University of London a colourful personality of wide experience, whose ripe judgment and keen sense of humour were a valued asset alike in the lecture theatre and in administrative bodies. He is widely known as the author, with Dr. P. Haas, of the "Chemistry of Plant Products", which first appeared in 1913. This work filled a definite gap in the botanical literature of Great Britain, and the same can be said of Hill's "Essentials of Botanical Illustration" published in 1915. As president of the Botanical Section of the British Association at the centenary meeting held in London in 1931, Hill showed his grasp of historical perspective. Prof. Hill, who was a student at the Imperial College of Science and Technology, was at one time lecturer at St. Thomas's Hospital, and the Goldsmiths' College, prior to his appointment to University College. At the latter he took an active part in the O.T.C. and became a major in the First World War. In his retirement he will pursue his horticultural leanings, where his physiological and æsthetic sense will continue to have full play.

Agricultural Economics at Aberystwyth: Prof. E. F. Nash

MR. E. F. NASH, who has been elected professor of agricultural economics and advisory economist in the University College of Wales, Aberystwyth, has recently been serving in the Food and Agriculture Branch of the Control Commission in Germany, where he has had responsibility for agricultural and food prices in relation to the cost of living and the control of inflation. He was educated at the City of London School and at University College, Oxford, where he held a classical scholarship. He took first-class honours in Classical Moderations, Greats and Modern Greats. In 1927 he was awarded a Commonwealth Fund Fellowship and proceeded to the University of Chicago, where he studied economics. Afterwards he lectured in economics at Queen's University, Kingston, Ontario, and in 1930 became staff tutor for extra-mural classes, University of Birmingham, where he lectured in economics and economic history. In 1930 he joined the staff of the

Economic Intelligence Branch of the Ministry of Agriculture and Fisheries, and as member of that staff gained special experience of inquiries in the field of agricultural statistics and economics. He specialized in the study of agricultural development as affected by the course of international trade, commercial policy and political conditions. In 1939 he joined the Food (Defence Plans) Department, which on the outbreak of war became the Ministry of Food, where he was associated with numerous inquiries of an economic character, and continued with that Ministry until the early part of 1945. Although Mr. Nash has not had any personal associations with the agricultural industry, he has combined a wide experience of inquiries into the economics of agriculture, food supplies and prices, with previous experience of intra- and extra-mural teaching.

Metallurgy in the University of Birmingham

THE University of Birmingham has received a gift of nearly £137,000 from constituent associations and members of the British Non-Ferrous Metals Federation. This munificent gift has been made in response to an appeal recently issued for £250,000 for the development of the Department of Metallurgy. The University intends to expand this Department to meet the need which has been repeatedly expressed by industry for more metallurgists. In addition to studying metallurgical science to the highest attainable level, the science of metallurgical production is being studied and new courses developed, which will be designed to provide industry with men specially qualified to apply new knowledge to industrial processes. In order to facilitate these new studies, a division of the Department has been created to study industrial metallurgy. This will not be regarded as an alternative subject to metallurgical science; courses of study for all students will be identical, at a high scientific level, until a late stage in the honours course, and any specialization will be confined to a relatively small portion of the degree course. Industrial metallurgy will be pursued intensively, principally as a subject for study by graduates in the same way as metallurgical science to-day is most completely dealt with in the universities of Britain. The Department of Metallurgy at Birmingham will be a unified department in which it is hoped to effect for all students an appropriate balance between the scientific and industrial aspects of the subject. Prof. D. Hanson, who has been professor of metallurgy for many years, has now been joined by Prof. L. Aitchison as professor of industrial metallurgy (see *Nature*, February 23, p. 222). It is hoped that graduates from other universities will take advantage of the new Department of Industrial Metallurgy for the purpose of graduate studies, in which appropriate courses will be arranged.

Science in India

IN his presidential address, "The Progress of Science in India", to the National Institute of Sciences of India, at the twelfth annual general meeting, held at Bangalore on January 1, Mr. D. N. Wadia referred to the recent announcement by the Education Department of the Government of India on the recognition of the Institute as the premier scientific organisation of the country, and to the Government building grant for 1946–47 of rupees 2,20,000 and recurring grant of rupees 1,17,000 towards the secretariat, national research fellowships, grants-in-aid for publications, etc. The Council of the Institute has also been entrusted with the administration of the endowment of the four research fellowships in India offered by Imperial Chemical Industries, Ltd., three of which have now been awarded. During the last two years the Institute has received from the Rockefeller Foundation of New York a grant of 15,000 rupees a year, which is being distributed to some twenty-three scientific societies and academies in India in aid of their publications. In view of its new status the Council of the Institute has now accepted responsibility as adviser to the Government on all scientific matters, the co-ordination of the activities of scientific academies, societies and institutions, the distribution of grants-in-aid to scientific publications, from funds provided by the Rockefeller Foundation or the Government, and the administration of funds for the award of research fellowships. At an early date it is expected that the work of the Institute will assume more and more the character of a national research council. A Provisional Research Grants Committee has already been established, and the Council proposes to take up immediately the constitution of the new research committees.

Reviewing the work of the Board of Scientific and Industrial Research, under which more than one hundred and twenty-five research schemes are at present in operation, Mr. Wadia refers to an increase in the Government allocation to the finances of the Board, the vote for the current year being estimated at rupees 30,00,000. The scientific work of the Board is carried out through some twenty research committees and he mentions in particular the work of the Metals Committee, the Electro-Chemical Industries Committee, the Fuel Research Committee, the Heavy Chemicals Committee, the Plastics Committee, Glass and Refractories Committee, the Dyestuffs Committee, and the Radio Research Committee. An offspring of the activities of the Board was the institution of the Industrial Research Planning Committee under Sir R. K. Shanmugham Chetty in December 1943, which presented a report early in 1945, recommending the organisation of a national research council for India. Mr. Wadia concluded his address with an outline of the salient features of the memorandum on the development of agriculture and animal husbandry in India by Sir P. M. Kharegat, commonly known as the Kharegat Plan, published by the Imperial Council for Agricultural Research.

Prehistory of Ceylon

THE early archæology of Ceylon is of considerable interest, but is as yet not well understood. Mr. P. E. P. Deraniyagala, director of museums, Ceylon, has devoted much time and thought to the matter; in *Spolia Zeylanica* (vol. 24, Part 2) he presents Part 2 of "Some Aspects of the Prehistory of Ceylon". It is to be regretted that it has not been found possible to employ a competent draughtsman who understands the technique of drawing stone implements, for the two photographs are well-nigh useless and the drawings little better; photographs of stone implements are seldom very helpful, but it is not impossible to produce first-class drawings. Several pages of the article are devoted to a proposed new typology of the artefacts. A description of the industrial finds of the Ratnapura and Balangoda culture phases, using the new typology, follows, and there is also a brief note on some cave paintings found at Mandagalgé. In conclusion, there is given a useful if tentative table of correlations and a bibliography.

Royal Institute of Chemistry

THE sixty-eighth annual general meeting of the Royal Institute of Chemistry was held on March 12. Referring in general terms to the annual report of the Council for 1945, the president, Prof. Alexander Findlay, said that membership of the Institute has increased by 459 to 9,641 and the register of students by 205 to 1,411. Since the conclusion of hostilities, the activities of the Institute had expanded, and the Council had been concerned with reviewing almost every feature of the structure and work of the Institute to see where modifications and new developments were required in order to meet post-war needs. In his presidential address, which followed, Prof. Findlay referred to the tasks and responsibilities of the Institute in post-war Britain, and said that chemists must play an important part in the work of improving the physical and material well-being of the community. In all matters of national interest on which the activities of chemists impinged and in which the knowledge and experience of its members gave it a right to speak or act with authority, the Institute must, in the public interest, be more active in undertaking the duties and responsibilities of leadership in a spirit of service to the community. The Institute, probably in collaboration with other bodies, should exert itself in order to bring about, in the minds of the people as a whole, a better understanding of the nature and importance of the work of chemists and a consequent increase in the esteem in which the profession of chemistry is held by the community. During the War, chemists had made an important contribution to the achievement of victory, and they could make a no less valuable contribution to the rebuilding of our national life and to increasing industrial prosperity. But they must, without any thought of domination on their part or of claiming to force decisions in matters which lay outside their special province, be admitted to full and free collaboration with those who had the responsibility of framing policy and of administering the affairs of the country.

Dr. G. Roche Lynch, senior official analyst to the Home Office and director of the Department of Chemical Pathology at St. Mary's Hospital, London, was elected president for the year 1946–47. Dr. D. W. Kent-Jones has been appointed treasurer in succession to Mr. J. C. White, who served during the war years.

West Wales Field Society

ALL who know Pembrokeshire and the work of its Bird Protection Society will be interested to learn from its interim report, dated January 1946, that the Society has decided to change its name. Dr. Julian Huxley, moving the adoption of the seventh annual report, explained the wish of the Society to broaden the basis of its work and to include botany, zoology, geology and archæology in addition to the study of bird life and the interests of the countryside in general. He therefore proposed that the Society be called the West Wales Field Society, and this proposal was unanimously adopted. Dr. Huxley also referred to the bombing of the island of Grassholm, pointing out that Grassholm is the only island home of the gannets in the southern areas of England. He also said that the Society had done valuable service by securing the islands off the coast of Pembrokeshire as sanctuaries. The Council of the Society has decided to rent the islands of Skomer (with Middleholm) and Skokholm for a while in order to try out the idea of establishing a field study centre there for the study of natural history and especially for the observation of the birds which use Skomer and Skokholm. The main centre will be at Skomer Island House, which can accommodate a small staff consisting of an honorary warden, a married couple to act as boatman and cook, and a succession of students. The Society has received the permission of Mr. Malcolm Stewart, one of its vice-presidents, to continue to supervise protection of the fauna of Grassholm and to do limited field work there. The Society's own yacht will be maintained for the use of its members. Something like £1,000 will be required for the maintenance of this field study centre during its first year, and the Society appeals for donations to support the work.

Bulletin of War Medicine

THE volume of scientific literature is nowadays so great, and the field that it covers is so wide, that no scientific worker can welcome the disappearance of a journal which abstracts any part of it. When the journal is one which has consistently maintained a high standard and has filled its pages with critical reviews written by experts it is even less pleasant to contemplate its disappearance. Yet we are no longer to have, after its issue of August 1946, the *Bulletin of War Medicine*. The Medical Research Council and the Bureau of Hygiene and Tropical Diseases, which issue it, have decided (*Bull. War Med.*, **6**, 61; 1945) that by that date the need for a journal of this kind will have been met. Now that the War has ended, it should become progressively less necessary to take into account the needs of medical officers serving overseas, so that it is proposed that the scope of the later issues of volume 6 shall differ somewhat in scope from that of the earlier issues. All the issues of the *Bulletin* will remain in print for the time being, so that the demand for complete sets of it can be met. The needs of medical men in the tropics will still be supplied by the *Tropical Diseases Bulletin* and the *Bulletin of Hygiene*, both of which are issued by the Bureau of Hygiene and Tropical Diseases.

Capacity Current Heating

THE demand for high-speed production in the war industries and the rapid advance made in radio technique during the War have been responsible for an expanding interest in the capacity current heating ('dielectric heating') of wood, rubber, plastic and other non-metallic materials. A report, Ref. Y/T6, entitled "Capacity Current Heating" prepared jointly by T. H. Messenger and D. V. Onslow, of the Research Association of British Rubber Manufacturers and the British Electrical and Allied Industries Research Association respectively, summarizes the position to date. The report is a résumé of published information and it deals with the theory of this method of heating and, in some detail, with its applications. Equipment and costs are also considered. The report is supported by a bibliography of 241 references. Copies of the report may be obtained from the British Electrical and Allied Industries Research Association, 15 Savoy Street, W.C.2 (*9s.* net, postage *3d.*).

Exhibition in Sweden of British Scientific Instruments

AN exhibition of British scientific instruments will be held in the Technical Museum, Stockholm, during May 24–June 4, under the joint auspices of the Scientific Instrument Manufacturers' Association of

Great Britain, Ltd., and the Royal Institute of Scientific and Engineering Research of Sweden. Noteworthy developments have been made during the war years, and instruments once in short supply and seen only in the laboratory are now mass-produced for industrial use without any loss of accuracy or reliability. Many of these instruments will be on show in Stockholm, and the whole exhibition should present a well-balanced picture of the products of British scientific instrument makers, serving to introduce them to a market formerly supplied by German firms. Forty-one British manufacturers are exhibiting examples of their latest apparatus, and in addition to the trade displays, a collection of photographs and of early instruments of historical importance has been organised by the British Council. Prominent British men of science, including Sir Charles Darwin, director of the National Physical Laboratory, will deliver addresses during the exhibition on various British achievements in the fields of science. Another feature will be films, illustrated lectures and demonstrations by the technical experts of some of the exhibiting manufacturers. These will cover such different instruments and applications as industrial tachometry, the diffraction theory of lens images, industrial applications of the spectrograph, and graphical methods of interpreting X-ray photographs of crystals.

"Annual Review of Microbiology"

THE Board of Directors of Annual Reviews, Inc., announces the forthcoming publication of an "Annual Review of Microbiology". The "Review" will be similar in format and in organisation of subject-matter to the "Annual Review of Biochemistry" and the "Annual Review of Physiology", and will be under the direction of an editorial committee consisting of Dr. Monroe D. Eaton, Department of Public Health, Berkeley, Calif.; Dr. Wallace E. Herrell, Mayo Clinic, Rochester, Minnesota; Dr. C. B. van Niel, Hopkins Marine Station, Pacific Grove, Calif.; Dr. J. M. Sherman, Cornell University, Ithaca, New York; Dr. E. C. Stakman, University of Minnesota, St. Paul, Minn.; and Dr. W. H. Taliaferro, University of Chicago, Chicago, Illinois. Prof. Charles E. Clifton, of Stanford University, has been appointed editor, and Prof. Sidney Raffel, Stanford University, and Prof. H. A. Barker, University of California, will serve as associate editors. The first volume is expected to appear in November 1947.

Announcements

MR. F. J. TRITTON, manager of the Technical Service Department of Ilford, Ltd., has been elected president of the Royal Photographic Society of Great Britain.

DR. D. A. JACKSON, lecturer in spectroscopy in the University of Oxford, has given the University endowments of £700 a year for seven years for research in any branch of physics, and £300 a year for seven years for astronomy or astro-physics or solar-physics research.

THE Royal Photographic Society has inaugurated a series of six Easter lectures on photography, specially adapted for juvenile audiences, which will be given at the Royal Geographical Society, Kensington Gore, London, S.W.7, at 3 p.m. on April 24, 25 and 26 and May 1, 2 and 3. Each lecture will be complete in itself. Mr. Percy W. Harris, secretary of the British Photographic Manufacturers' Association and editor of the *Miniature Camera Magazine*, and Dr. D. A. Spencer, of the Kodak Research Laboratory, will deliver the lectures, the fee for which is 10*s*. 6*d*. Information and tickets can be obtained from the Honorary Secretary, Royal Photographic Society, 16 Princes Gate, London, S.W.7.

A MINISTRY of Education course for engineering teachers in technical colleges will be held at New College, Oxford, during July 22–August 1. It is designed primarily for teachers engaged in national certificate work, in mechanical, civil, production and electrical engineering, and other courses of a similar syllabus content. Full particulars of the course are obtainable from the local education authority, or direct from the Ministry of Education.

A CONFERENCE on the planning and equipment of special libraries has been arranged by the Association of Special Libraries and Information Bureaux and will be held at the Royal Institute of British Architects, 66 Portland Place, London, W.1, on April 6. The planning and equipment of university and college libraries will form the main subject of the morning session; the afternoon will be devoted to similar problems with special reference to research organisations and industrial concerns. Applications to attend should be sent to the General Secretary, ASLIB, 52 Bloomsbury Street, London, W.C.1, as soon as possible.

THE Society of Dyers and Colourists is arranging a symposium on "Fibrous Proteins, Natural and Synthetic", to be held in the University of Leeds during May 23–25. The meeting will have an international character, for eminent scientific men from the British Empire, the United States and Europe have promised original papers. Applications for hotel accommodation should be sent as soon as possible to Mr. H. Foster, the honorary secretary of the Symposium Committee, at the Society of Dyers and Colourists, 32–34 Piccadilly, Bradford.

THE following appointments have been made in the Colonial Service: L. F. Derraugh, to be agricultural officer, Gold Coast; T. O. Ellis, to be agricultural chemist, Jamaica; D. H. Maggs, to be botanist, Nigeria; H. Owen, to be plant pathologist, Gold Coast; J. E. Rockingham, to be geologist, Nigeria; J. A. Austin, to be agricultural officer, Sierra Leone; R. W. Eccles and J. M. Halcrow, to be agricultural officers, Gold Coast; J. S. Gunn and D. Morrison, to be agricultural officers, Tanganyika; J. W. Next and E. S. T. Marshall, to be agricultural officers, Uganda; P. A. Jones, to be agricultural officer, Kenya; B. C. King, chemist and petrologist, Uganda, to be mineralogist, Geological Survey Department, Nigeria.

FIVE years have gone by since the last issue of *Crookes Digest*. Now it has reappeared, as a slim pamphlet, containing short, unsigned articles on proteins in medicine, the school child's posture, hormones and the skin, and reactions of sulphonamides. It is issued by the Crookes Laboratories, Park Royal, London, N.W.10, for the use of medical men and others interested.

ERRATUM. The discussion on the chemistry of macromolecules under the auspices of the Chemical Society on April 4 will take place at the Institution of Mechanical Engineers, not at the Chemical Society, as stated in *Nature* of March 16, p. 332.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Pituitary Adrenotropic Hormone, Extract of Suprarenal Cortex, Lymph, and Lymphoid Tissue

WITHIN the past few years, attention has been directed to the effect on lymphoid tissue of pituitary adrenotropic hormone[1]. Dougherty and White[1] described a direct depressant effect of the hormone on lymphoid tissue, while Reinhardt and Li[1] associated this with an observed diminution in the thoracic duct lymphocytes entering the blood.

In experiments with cats, the lymphocytes, dry substance, fat and nitrogen were investigated in thoracic duct lymph. The lymphocyte content markedly diminishes after intraperitoneal injection of 300 units of pituitary adrenotropic hormone, thus agreeing with the observations of Reinhardt and Li[1]. In these experiments, furthermore, the fat diminishes, as also does the flow of lymph and the dry substance. The fat content calculated as percentage of dry substance falls by more than 40 per cent, while the nitrogen also decreases. A typical experiment is shown in Fig. 1. The lowered fat content of the lymph is especially interesting in view of the findings of Reiss, Epstein and Gothe[2], concerning the part played by corticotropic hormone in fat metabolism.

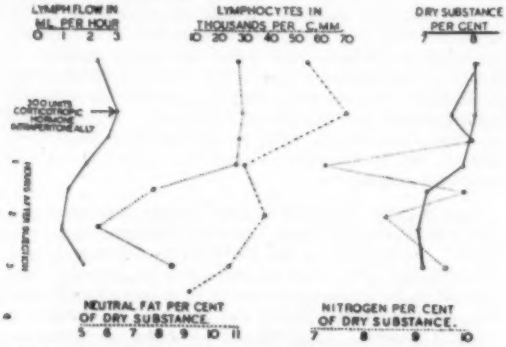

LYMPH FLOW IN ML. PER HOUR
0 1 2 3
LYMPHOCYTES IN THOUSANDS PER C.MM.
10 20 30 40 50 60 70
DRY SUBSTANCE PER CENT.
7 8
200 UNITS CORTICOTROPIC HORMONE INTRAPERITONEALLY
HOURS AFTER INJECTION
NEUTRAL FAT PER CENT OF DRY SUBSTANCE
5 6 7 8 9 10 11
NITROGEN PER CENT OF DRY SUBSTANCE
7 8 9 10

Fig. 1. EFFECT OF CORTROPHIN ON LYMPH FLOW, LYMPHOCYTES, DRY SUBSTANCE, NEUTRAL FAT AND NITROGEN IN THORACIC LYMPH DUCT OF CAT.

In rats given cortrophin, the blood showed an absolute lymphopenia in eight cases out of twelve, at times varying from 2·75 to 5·25 hr. after intraperitoneal injection. With daily injections of cortrophin, or of cortical extract (eschatin) the potency of which had previously been tested by the atrophic changes induced in the suprarenals of normal animals, the blood changes varied. Out of eight experiments in which injections were given daily for 28 days, cortrophin (three experiments) produced a rise in the blood lymphocytes, eschatin (three experiments) a fall, and cortrophin + eschatin (two experiments) also a fall.

In the lymphoid tissues, eschatin given daily for 28 days produced, surprisingly enough, a hyperplasia (Figs. 2 and 3), in spite of the lowering of the blood lymphocytes. The results indicate that the interpretation of the blood changes may not be quite so simple as has been thought. Lymphopenia may possibly be associated with increase in the number of newly formed lymphocytes entering the blood if at the same time the number leaving the blood is increased still further; or, in the terminology employed by Drinker and Yoffey[3], the lymphopenia would be of the X+/Y+ + type.

In the eschatin experiments there was no convincing evidence of increased lymphocyte destruction as reported by Dougherty and White[1], but the animals were killed 24 hours after the last injection

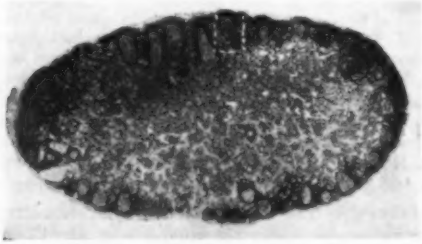


Fig. 2. PHOTOMICROGRAPH OF A SECTION THROUGH THE SUBMANDIBULAR LYMPH NODE OF AN ADULT RAT, TREATED DAILY FOR 28 DAYS BY SUBCUTANEOUS INJECTION, WITH 1 DOG UNIT OF ESCHATIN PER 100 GM. BODY WEIGHT. × 12.

Fig. 3. PHOTOMICROGRAPH OF THE GERMINAL CENTRE SHOWN WITHIN THE DOTTED LINES IN FIG. 2. × 310.

of eschatin, by which time over-compensatory replacement of destroyed lymphocytes might have occurred.

This is a preliminary report, and fuller observations will be reported elsewhere.

J. M. YOFFEY.
M. REISS.
J. S. BAXTER.

Department of Anatomy,
The University, Bristol;
Endocrinological Department,
Burden Neurological Institute,
Bristol. Nov. 26.

[1] Dougherty, T. F., and White, A., *Endocrin.*, **35**, 1 (1944). White, A., and Dougherty, T. F., *Endocrin.*, **36**, 16 (1945). Dougherty, T. F., and White, A., *Amer. J. Anat.*, **77**, 81 (1945). Ingle, D. J., *Proc. Soc. Exp. Biol. and Med.*, **38**, 443 (1938). Simpson, M. E., Li, C. H., Reinhardt, W. O., Evans, H. M., *Proc. Soc. Exp. Biol. and Med.*, **54**, 135 (1943). Reinhardt, W. O., Aron, H., and Li, C. H., *Proc. Soc. Exp. Biol. and Med.*, **57**, 19 (1944). Reinhardt, W. O., *Proc. Soc. Exp. Biol. and Med.*, **58**, 123 (1945). Reinhardt, W. O., and Li, C. H., *Science*, **101**, 360 (1945).
[2] Reiss, M., Epstein, H., and Gothe, I., *Exp. Med.*, **101**, 69 (1937).
[3] Drinker, C. K., and Yoffey, J. M., "Lymphatics, Lymph and Lymphoid Tissue" (Harvard University Press, 1940).

Tropomyosin : a New Asymmetric Protein Component of Muscle

AN unusual protein of fibrous character has been isolated from the fibrillar fraction of skeletal and cardiac muscle. It is simply prepared by washing away the sarcoplasmic components of finely minced muscle and dehydrating the residue in ethanol and then in ether. The debris, consisting mainly of stroma protein and of myosin denatured *in situ*, is soaked in a molar solution of potassium chloride at pH 7, when a clear viscous extract is obtained containing tropomyosin and other proteins which are then precipitated at pH 4·5. After redispersal at pH 7, the contaminating proteins are largely denatured, and are almost quantitatively removed in ammonium sulphate solutions of 41 per cent saturation. The tropomyosin, precipitated between 49 and 60 per cent saturation, is filtered, dissolved, dialysed and purified by repeating the isoelectric precipitation and salting-out procedures.

Ultracentrifugation at pH 6·5, and electrophoresis at pH 6·5 and 2·9 (that is, above and below the isoelectric point of 5·5) have established the homogeneity of the preparation. The sedimentation constant (kindly determined by Dr. A. G. Ogston) was $2{\cdot}6 \times 10^{-13}$ for a protein concentration of 0·6 per cent; this, combined with a diffusion constant of $2{\cdot}35 \times 10^{-7}$ (obtained by Mr. H. Gutfreund at the same protein concentration) and a partial specific volume of 0·73 gives a molecular weight of 104,000. Osmotic pressure measurements as a function of protein concentration, with subsequent extrapolation of π/c values to c_0, give the rather lower value of 88,000. It is possible that a similar extrapolation of sedimentation and diffusion data obtained for different protein concentrations may give a molecular weight agreeing more closely with that from osmotic pressure determinations.

In salt-free solutions between pH 6 and 7 tropomyosin is exceedingly viscous and shows intense (positive) flow-birefringence. A solu-

tion of 0·82 per cent concentration has a relative viscosity of 52; on addition of potassium chloride to 0·1 *M* the viscosity falls to a value of 3·3 and flow-birefringence disappears. Both in absence and presence of salts the protein precipitates at *p*H 4·5–5 and redissolves below *p*H 4·2. Its solubility above *p*H 6 is not affected by heat treatment at any *p*H, nor is it rendered insoluble by organic solvents, strong urea solutions or trichloroacetic acid.

The fibrous character of the protein is indicated by the high frictional ratio of 3·1, the high viscosity, and the X-ray investigations carried out by Prof. W. T. Astbury and Mr. L. C. Spark. These latter reveal that tropomyosin belongs to the keratin-myosin-fibrinogen group. A dried film photographed with the X-ray beam perpendicular to the surface gives a disoriented pattern of the *α*-type in which the 5·1 A. spacing is unusually clear and strong, while the same film photographed with the beam parallel to the surface gives a partially oriented fibre pattern. The *α*-fold appears to survive treatments (such as stretching or squeezing in the cold moist state) which generally bring about the *α*-*β* transformation, but it is found that a strong *β*-pattern appears on heating to 105° or on squeezing between pieces of plate-glass that have first been heated in steam; and in the *β*-films produced by the latter method, not only do the main chains tend to lie parallel to the film, but also the side chains tend to stand perpendicular to the film, just as has been observed with keratin and myosin.

Tropomyosin contains no phosphorus, carbohydrate or hexosamine. Its amino-acid composition resembles that of myosin itself, especially with respect to the monoamino-monocarboxylic acids, determined chromatographically by Dr. G. R. Tristram. Differences are found in the high lysine nitrogen (18 per cent of the protein nitrogen as compared with 12·6 per cent for myosin), in the lower amide nitrogen (4·94 per cent, as against 7·2 per cent) and in the complete absence of tryptophan. The dicarboxylic acids, as yet undetermined, must be equivalent to the total base plus amide-nitrogen since the isoelectric point is in the acid *p*H range. It seems probable indeed that tropomyosin is unique among proteins in carrying the highest known valence both of positive and negative type. This property is obviously related to the aggregation phenomena implied by the high viscosity of tropomyosin in absence of salt.

The function of tropomyosin is as yet unknown. Since it is not present in the sarcoplasm it would appear to be associated with the fibril itself, where it is firmly bound either to the myosin or to some other structural component or to both. Though water-soluble after isolation, it is only extracted by salt solutions from ethanol-treated muscle, and without the latter treatment only partial extraction is possible. These facts suggest that *in situ* it forms an insoluble complex both with lipid and with protein, possibly myosin, from which it is liberated by a process of metathesis in presence of salt. The amount extracted is a linear function of salt concentration up to $\mu = 1$, and thereafter is maximal. The yield from rabbit skeletal muscle is 0·5 gm./100 gm. wet muscle weight, and rather more (1 per cent) in the case of very young animals.

The exact relation of tropomyosin to myosin itself is equally obscure, but the analytical and structural similarities indicate that it is a species of myosin differing mainly in the length of the polypeptide chain. In proposing the present name, we have deemed it desirable to retain the word 'myosin' and to add a prefix which suggests this specific relationship. Experiments have shown that tropomyosin is not derived from myosin itself by the disaggregation of denatured myosin in presence of salts, nor by any kind of post-mortem catheptic activity. 'Purified' myosin (that is, three times precipitated) itself contains about 0·1 per cent of tropomyosin, but the association is probably fortuitous; and current experiments do not indicate that it is responsible for the adenosinetriphosphatase activity of the myosin complex. It may conceivably be a precursor of myosin, a fragmentary chain used in the elaboration of the gigantic myosin molecule. It should be noted that the protein is unrelated to the actin preparations of Straub[1], for which no criteria of homogeneity have been advanced; unlike tropomyosin, these are susceptible to denaturing processes and show an increased rather than a decreased viscosity on addition of salt.

KENNETH BAILEY.

Department of Biochemistry,
Cambridge. Jan. 11.

[1] Straub, F. B., *Stud. Inst. Med. Chem. Univ. Szeged*, **3**, 23 (1943).

Absence of Pseudo-Cholinesterase from the Tissues of Ruminants

In a previous paper[1] it was mentioned that the non-specific or pseudo-cholinesterase is absent from the blood and tissues of ox and sheep. Although the experiments with blood were conclusive[2], an observation, difficult to interpret at that time, was made with one of the tissues examined, namely, beef kidney. This tissue was found to be capable of hydrolysing benzoylcholine, a compound suggested by Mendel, Mundell and Rudney[3] as a substrate suitable for measuring the activity of pseudo-cholinesterase. The activity towards this substrate, however, proved to be resistant to a concentration of eserine which inhibits the pseudo-cholinesterase in other mammalian tissues—a fact which made it appear unlikely that the enzyme in beef kidney was a pseudo-cholinesterase.

Sawyer's demonstration of the existence of an esterase capable of hydrolysing benzoylcholine[2] offers an adequate explanation for this discrepancy. Benzoylcholine esterase, which, according to Sawyer, is present in the liver of certain rodents, hydrolyses benzoylcholine but not acetylcholine. Recent experiments in this laboratory[4] have shown that benzoylcholine esterase is not inhibited by 2×10^{-6} *M* eserine, a concentration which inhibits the activity of pseudo-cholinesterase. Experiments based on this finding reveal that the hydrolysis of benzoylcholine by beef kidney is due to benzoylcholine esterase, since the activity of this tissue towards benzoylcholine is insensitive to eserine in the above-mentioned concentration.

Other tissues of ox and sheep which, by their inability to hydrolyse benzoylcholine, were shown to contain no pseudo-cholinesterase are liver, spleen, pancreas, muscle (Masseter), gastric mucosa, intestinal mucosa, thyroid gland, parotid gland, adrenal gland, sublingual gland, lachrymal gland.

The fact that pseudo-cholinesterase, previously shown to be absent from brain tissue throughout the animal kingdom[5], has now been found to be absent from the tissues of ox and sheep, is a further indication of the irrelevance of this enzyme to the process of nerve impulse transmission.

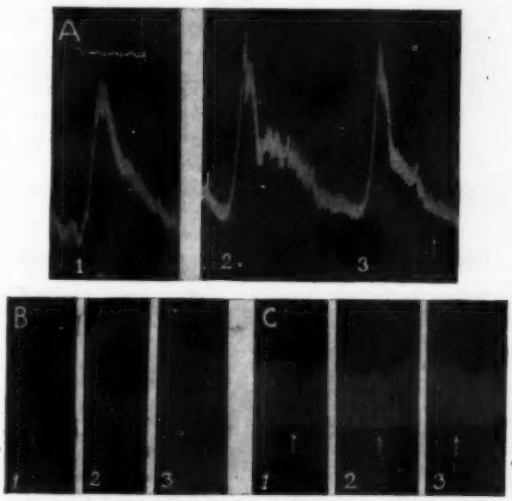
JOSEPHINE M. GUNTER.

Banting and Best Department of Medical Research,
University of Toronto, Toronto. Nov. 1.

[1] Mendel, B., and Rudney, H., *Science*, **100**, 499 (1944).
[2] Mendel, B., Mundell, D. B., and Rudney, H., *Biochem. J.*, **37**, 473 (1943).
[3] Sawyer, C. H., *Science*, **101**, 385 (1945).
[4] Mendel, B., and Gunter, J. M., unpublished experiments.
[5] Mendel, B., and Rudney, H., *Science*, **98**, 201 (1943).

A Substance with Sympathin E Properties in Spleen Extracts

ALCOHOLIC extracts of fresh spleen from cattle contain high amounts, up to 10 μgm. adrenaline equivalents per gm. tissue, of a cardio-accelerator and blood-pressure raising substance, showing the characteristic properties of a sympathomometic catechol compound[1]. The active substance was taken up in an ether solution of organ lipids and extracted from this with a 5–10 per cent solution of sodium sulphate. A further purification was attained by treatment with sublimate in alcohol, which left the active substance in the filtrate. The purified extract was found to differ from adrenaline in the following respects. Ergotamine, in a dose which inhibited or reversed the action of adrenaline, was not equally effective in inhibiting the pressor action on the cat's blood-pressure; the isolated uterus of the virgin or non-pregnant cat was rather less inhibited than by an equipressor dose of adrenaline, and the same applied to the isolated intestine of the rabbit. The relative dilating effect on the iris was considerably greater with adrenaline. Whereas equipressor doses of adrenaline and the spleen pressor substance gave similar catechol reactions with ferric chloride, the fluorescence reaction in alkaline solution[2] was absent in purified spleen extracts. The active substance in spleen thus conforms better with an amino-base, such as *nor*-adrenaline, than with adrenaline.



A, BLOOD PRESSURE, CAT; *B*, ISOLATED VIRGIN CAT'S UTERUS; *C*, ISOLATED RABBIT'S JEJUNUM; 1, 2 μGM. ADRENALINE; 2, 0·1 PURIFIED SPLEEN EXTRACT; 3, 2 μGM. 3,4-DIHYDROXY-*nor*-EPHEDRINE.

Direct comparison of equipressor doses of adrenaline (I), 3,4-dihydroxy-*nor*-ephedrine (II) and spleen extracts (III) with regard to biological tests, colour and fluorescence reactions gave much closer agreement between (II) and (III) than between (I) and (III) (see figure). Dioxy-*nor*-ephedrine, on the other hand, is similar in action to the amino-base *nor*-adrenaline, which in its turn closely resembles the effect of stimulation of certain adrenergic nerves[3]. The good agreement between the action of purified spleen extracts, *nor*-adrenaline and the mediator of hepatic nerve stimulation[4] suggests, first, that the active substance in spleen is closely related to *nor*-adrenaline, and, secondly, that the spleen substance is, in fact, the postulated sympathin E.

U. S. v. EULER.

Physiology Department,
Karolinska Institutet,
Stockholm. Nov. 20.

[1] Euler, U. S. v., *Nature*, **156**, 18 (1945).
[2] Gaddum, J. H., and Schild, H., *J. Physiol.*, **80**, 9 P (1934).
[3] Barger, G., and Dale, H. H., *J. Physiol.*, **41**, 19 (1910).
[4] Cannon, W. B., and Rosenblueth, A., *Amer. J. Physiol.*, **104**, 557 (1933). Greer, C. M., Pinkston, J. O., Baxter, J. H., and Brannon, E. S., *J. Pharm. Exp. Ther.*, **62**, 189 (1935).

Effect of Ions upon the Production of Vitamins in the Yeast Cells

In the course of an investigation of the nutritional requirements of insects in mineral elements, we were confronted with a peculiar instance of an effect exerted by salt ions upon the production of one of the vitamins. The wax moth *Galleria mellonella* can be reared on a medium composed of one part of yeast and two parts of wax. However, if in place of commercial bakers' yeast, yeast grown in the laboratory be used, the result will depend upon the composition of the culture medium.

It has been previously shown that yeast can be grown in a pure synthetic medium completely deprived of sodium and calcium salts, for example, in a medium of the following composition: 2 per cent purified dextrose, 0·1 per cent potassium dihydrogen phosphate, 0·3 per cent ammonium sulphate, 0·1 per cent magnesium sulphate (Rubinstein and Burlakowa[1]). Although many strains of yeast (especially common baker's or brewer's yeast) exhibit very poor growth in such media and can be markedly stimulated by the addition of sodium and calcium, some species of yeast, for example, *Torula utilis* or *Mycoderma cassi*, develop fairly well in this sodium- and calcium-free culture medium.

However, larvæ of the wax moth failed to develop if fed on such yeast mixed with wax in the usual proportion. The use of yeast grown in the presence of 0·1 per cent sodium chloride and 0·1 per cent calcium chloride, or even only of sodium chloride, was sufficient to render the medium adequate for the development of the insect, although there was no visible difference between the two yeast cultures. It should be emphasized that sodium ions must be present during the actual *growth* of the yeast: addition of sodium and calcium salts to the yeast – wax mixture proved entirely inefficient and did not enhance its nutritive value for *Galleria* in any way.

Development of the moth could be fully restored and proceeded at its usual rate if an aqueous or alcoholic extract of normal yeast was added to the deficient nutrient medium. The yeast extract could be autoclaved at 130° in a strongly alkaline solution without impairment of its growth-promoting activity. On the other hand, addition of normal yeast repeatedly washed with an excess of hot water was no longer efficient in stimulating the development of *Galleria* on the deficient food mixture. It can be inferred that the elimination of sodium ions prevents the production in the growing yeast of some water-soluble vitamin, which is supposed to be a thermostable component of the vitamin B group. A special test showed that this was not nicotinic acid, the importance of which for the developing wax moth was reported previously (Rubinstein and Shekun[2]).

It is thus possible at will to stimulate or prevent the production in the yeast cell of a growth-promoting factor (a thermostable component of the B vitamin group?) merely by changing the ionic composition of the nutrient medium. The exact nature of this factor has yet to be identified.

D. Rubinstein.
L. Shekun.

Department of Biophysical Chemistry,
All-Union Institute of Experimental Medicine,
Moscow. Nov. 19.

[1] Rubinstein, D., and Burlakowa, H., *Biochem. Z.*, **271**, 324 (1934).
[2] Rubinstein, D., and Shekun, L., *Nature*, **143**, 1064 (1939).

Preservation of Ascorbic Acid in Vegetables by Hydrogen Sulphide during Air-Drying

During the drying of vegetables in a hot-air current, a loss in the ascorbic acid contents will generally be found. This is largely due to the action of oxidizing enzymes, which must therefore be destroyed if the losses are to be diminished. This can be done by treating the vegetables in hot water or steam (so-called scalding or blanching), but by this process the non-enzymic oxidation of the ascorbic acid is accelerated on account of the rise in temperature, and so the treatment must be followed immediately by drying.

Another way of destroying the enzymes is to introduce chemicals into the vegetables which are able to react with the prosthetic or protein part of the enzyme molecule. This has been tried by Morgan[1], who dried figs after treatment with sulphur dioxide, but the influence on the ascorbic acid retention was poor. Another way was described by Allen, Barker and Mapson[2], who recommended blanching in hot water containing sulphite. Further details were not given.

It has now been found that a pre-treatment of fresh vegetables with gaseous hydrogen sulphide has a marked effect on the retention of ascorbic acid contents during hot-air drying. In the accompanying table is shown the percentage retention of ascorbic acid in some vegetables, dried without any treatment and after treatment with concentrated gaseous hydrogen sulphide for an hour and blowing out excess of the gas with atmospheric air until the smell had disappeared.

Clearly, in all cases of materials treated with hydrogen sulphide the losses of ascorbic acid are very small compared with the losses in untreated materials.

Furthermore, it has been found that kale treated with hydrogen sulphide can be stored for 24 hours at 20° C. and then dried in a current of hot air with very little loss of ascorbic acid. Thus the gas can be used to protect the ascorbic acid in vegetables during storage before drying.

It is not necessary to use concentrated hydrogen sulphide, for only 1 per cent of it in atmospheric air had the same effect. In the case of the treatment of kale, full protection with this mixture was obtained in 2 hours, but even after 15 minutes it was possible to dry the vegetable with a loss of 22 per cent against 72·2 per cent in untreated kale. The process was in this case carried out at 60° C., and at this temperature the loss was somewhat greater than that at 90° C.

The flavour, smell and colour of the vegetables are not changed by the treatment, and the rise in sulphur contents is not significant.

The ascorbic acid contents were estimated by reduction titration with 2·6 dichlorophenol-indophenol; and a biological control, carried out in the State Vitamin Laboratory in Copenhagen, showed that the reduction value in the materials was due to ascorbic acid.

In other experiments a good effect was found by blanching the vegetables before drying, but this effect was inferior to that of hydrogen sulphide treatment, and certain materials, such as white cabbage, were easily discoloured by the process.

Vegetable	Temperature of air current	Ascorbic acid retained (per cent)	
		Untreated material	H_2S-treated material
Kale	90° C.	66·7 per cent	98·5 per cent
Cabbage, white	60	64·4	95·4
" summer	60	44·2	92·6
Lucerne	90	26·0	77·3
Parsley	90	77·4	96·1
Chervil	90	20·3	101·4

Ettrup Petersen.

Chemical Laboratory,
Atlas, Ltd.,
Copenhagen.

[1] Morgan, *Amer. J. Pub. Health*, **25**, 328 (1935).
[2] Allen, Barker and Mapson, *Nature*, **150**, 223 (1942).

Waterproofing Mechanism of an Insect Egg

Recent work[1,2] has shown that the cuticles of many insects are waterproofed by wax which occurs as a layer, approximately 0·25 μ thick, on the outermost surface of the cuticle.

A study of the eggshell of *Rhodnius prolixus* (Hemiptera) has revealed that the chorion, secreted by the cells of the follicle, consists of seven distinct layers; these appear to be modifications of a proteinaceous material. A cement is added to the external surface of the shell at oviposition. However, all these layers are freely permeable to water; they cannot account for the considerable resistance of the egg to desiccation.

It has been found that the waterproofing mechanism of the egg consists of a wax layer, approximately 0·25 μ thick, which covers the inner surface of the shell. This wax is apparently of similar composition to the cuticular waxes of insects[2] and gives the egg a characteristic 'transition point' in its temperature/water-loss curve at 42·5° C. It is a product of the maturing oocyte and may be secreted on to the shell before or after the follicle cells have completed the chorion. Oocytes with half-formed chorions, stripped of their follicle cells, will waterproof themselves if incubated in osmotically balanced Ringer's solution at 25° C. for three days. Waterproofing, therefore, is independent of the formation of the chorion, and, probably, of follicular activity.

The waterproofing process is also independent of changes due to fertilization. Sterile eggs are waterproofed and fertilization produces a true fertilization membrane. This membrane is freely permeable to water; it lies between the wax layer and the developing embryo, and supports the wax across the inner openings of the micropyles.

A detailed account of these and other features of eggshell structure and permeability will appear elsewhere.

J. W. L. Beament.

Agricultural Research Council Unit of Insect Physiology,
Department of Zoology,
Cambridge. Nov. 27.

[1] Wigglesworth, V. B., *J. Exp. Biol.*, **21**, 97 (1945).
[2] Beament, J. W. L., *J. Exp. Biol.*, **21**, 115 (1945).

Extrusion of Nucleic Acid from the Nuclei of Human Granulocytes

Petri[1] described "kleine gestellte Kernprominenzen", small, stalked, deeply staining buds attached to the contorted ring-like nucleus of the mature neutrophil leucocyte of the mouse. La Cour[2] showed that they arise from the deeply staining heterochromatic parts of the nucleus, that they are Feulgen-positive and so contain desoxyribose nucleic acid, and are ultimately split off and lie free in the cytoplasm.

Similar buds are present in human neutrophil and eosinophil leucocytes. Commencing as eminences on a heterochromatic body, they develop a stalk, which lengthens, thins, and ultimately ruptures, leaving the bud free in the cytoplasm. They develop from segmented

× 1,200.

nuclei, especially from those with three or more lobes, and are extremely rare in cells with rod-shaped nuclei: they do not occur in less mature cells. They have been observed in all specimens of blood examined, both normal and from patients suffering from a variety of diseases including myeloid leukæmia; usually they can be found only in the more common neutrophils, but they can easily be found in the eosinophils when these cells are numerous. Attempts to demonstrate them in the living cell by direct or by dark-ground illumination were frustrated by the presence of the specific granules.

The buds are easily seen in thin Romanowsky preparations, but are better studied in Feulgen-light-green preparations, since in these no confusion can arise between a freed bud and a coarse neutrophil granule. Buds lying free in the cytoplasm are, however, extremely rare, as only about half a dozen have been seen in several hundred slides.

This extrusion of nucleic acid occurs in a cell which is at the height of its physiological powers, but incapable of further division. Since the human granulocyte does not become more basophilic with increasing age, it is improbable that conversion to ribose nucleic acid occurs. The process appears too orderly and constant for it to be an artefact, or for it to be termed karyorrhexis, unless the whole process of nuclear segmentation is to be included in this term.

I am indebted to Mr. P. A. Toller of the Maxillo-Facial Unit for the photograph.

GEORGE DISCOMBE.

St. Bartholomew's,
at Hill End (E.M.S.) Hospital,
St. Albans. Nov. 13.

[1] Petri, S., *Acta Path. Microbiol., Scand.*, **10**, 159 (1933).
[2] La Cour, L. F., *Proc. Roy. Soc. Edin.*, **62**, 73 (1944).

X-Ray Examination of Self-Recovery in Metals

MANY investigations of the distorted state of cold-worked metals have been carried out by means of X-ray powder photographs: partly of polycrystalline rods, partly of filed powders. In this respect X-ray photographs may show some interesting phenomena: (*a*) broadening of the reflexion lines; (*b*) shift of the reflexion lines; (*c*) decrease of the reflexion intensities; (*d*) change in the spottiness of not completely smooth powder lines.

In a recent communication, Megaw, Lipson and Stokes[1,2] mention a recovery effect in filed metal powders. The X-ray photographs of freshly filed copper powders show broadened reflexion lines, especially for the higher order reflexions, probably originating in a more or less homogeneous deformation of the crystallites or mosaic elements. From photographs with the same specimen taken some days after its preparation, it became obvious that the distortion in the powder grains had been restored in such a way that the line broadening had been considerably reduced.

It may be of some interest that the recovery of copper filings has been demonstrated in our own X-ray photographs by means of a quite different effect. During an investigation of filed copper powders, two X-ray photographs of one specimen had been prepared at an interval of some months (see Figs. 1 and 2). The powder specimen was in the form of a thin layer. A flat film was placed behind the specimen; both specimen and film were perpendicular to the primary beam. The photographs only show two reflexions with a small angle of deviation (111) and (200) (the weak circles are β-components). A striking difference between the photographs is the occurrence of a great many distinct spots on the reflexion lines in Fig. 2, indicating the occurrence of a number of rather large crystallites. This effect has been verified in photographs of a number of specimens of the same material with the same interval of time.

The correct correlation of the effects responsible for the decrease of line broadening, mentioned by Megaw *et al.*, and the effect reported above is open to discussion.

In a metal powder, obtained by filing from a polycrystalline rod, the individual powder grains consist generally of a large number of more or less perfect crystallites with totally independent orientations. As a consequence of the deformed state of the metal, the individual crystallites are not perfect and consist of a great number of mosaic elements with only very small disorientations with respect to each other. With increasing deformation of the powder grains, the sizes of the crystallites decrease until they become of the order of those of the mosaic elements. Now it is important to correlate this subdivision of crystal aggregates into crystallites and mosaic elements with the patterns of crystal structure deformation that are usually held responsible for the various X-ray diffraction phenomena[3,4]. Thus, for example, line broadening may be supposed to originate in more or less homogeneous strains of the individual mosaic elements; decrease of reflexion intensities in the occurrence of a heavily distorted crystal structure in the boundaries between those elements; spottiness of reflexions in the occurrence of rather large crystallites. Such suppositions are only justified when they are compatible with the interdependence of the various effects in different states of the material.

In this way Brindley[5] investigated simultaneously line broadening and reflexion intensities and found that for metals with a large line broadening effect the intensity effect was small, while also the reverse was true.

Wood[6] investigated simultaneously spottiness, line broadening and line displacement in X-ray photographs of polycrystalline rods and obtained interesting results on a 'dispersed crystallite formation' and on the correlation of line shift and line broadening.

In the same way an investigation of recovery effects in cold-worked metals may furnish an excellent tool of investigation into the correlation of the various phenomena in a cold-worked metal. Besides line broadening and spottiness effects, an investigation of line shifts, intensity variations and extinction effects of powder filings is possible. If these phenomena, too, vary in the course of time, such investigation may provide a great deal of experimental material about the state of distortion of the metal studied.

L. L. VAN REIJEN.

Röntgeninstituut Technische Hoogeschool,
Laboratorium voor Technische Physica,
Delft. Nov. 27.

[1] Megaw, H., Lipson, H., and Stokes, A. R., *Nature*, **154**, 145 (1944).
[2] Megaw, H., and Stokes, A. R., *J. Inst. Metals*, **71**, 279 (1945).
[3] "Report of a Conference on Internal Strains in Metals" (Bristol, 1939), *Proc. Phys. Soc.*, **52**, 1 (1940); especially Bragg, W. L., *Proc. Phys. Soc.*, **52**, 105 (1940).
[4] Bragg, W. L., *Nature*, **149**, 511 (1942).
[5] Brindley, G. W., *Proc. Phys. Soc.*, **52**, 117 (1940).
[6] Wood, W. A., *Proc. Phys. Soc.*, **52**, 110 (1940).

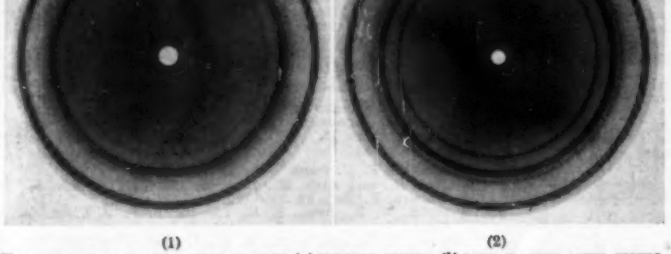
Electrical Properties of Tungsten Oxide Films

WHILE auto-electronic emission from a clean, smooth metallic surface can only occur under intense electric fields—fields too strong to employ in the presence of a gas because of the danger of disruptive currents—under certain conditions of the metal surface comparatively strong electron currents are known to occur with macroscopic electric fields as low as 10^5 V./cm. Such conditions are those obtaining when the metal surface is covered with thin oxide layers or dust particles[1,2]. The occurrence of such cold-cathode emission in a gas opened up the possibility of devising a self-triggering, two-electrode spark gap of practical interest in the field of electronics, and with this object experiments were carried out on the electrical properties of tungsten electrodes on which were formed films of oxides of tungsten.

A measure of the intensity of any cold-cathode emission from such electrode surfaces in a gas under an electric field may be obtained from a study of the behaviour of a short spark gap using those electrodes, when the applied electric field is impulsive and breakdown takes place on a rising wave-front of E.M.F. Under these conditions, a low concentration of initial electrons produces a time-lag of sparking, and the actual value of the potential across the gap just at breakdown can be used as a measure of the concentration of the initial electrons, when the form of the applied pulse of E.M.F. is known. In this way the properties of rough and oxidized surfaces of tungsten in air and nitrogen at atmospheric pressure were investigated. The variation of the distribution of time lags with cathode material for high gas pressures has been recorded by Cobine and Easton[3].

In the present experiments at atmospheric pressure, it was found that with electrodes rendered smooth by a certain amount of pre-sparking, long time-lags of 2×10^{-4} sec., and longer, were observed. In fact, the gap sometimes refused to break down with the pulse employed even when the applied E.M.F. was twice the static sparking value, thus indicating that the electron emission from the clean metal was very low. On the other hand, when films of certain oxides of tungsten had been formed, mainly by pre-sparking and allowing the electrodes to stand in air, spark time-lags as low as 5×10^{-6} sec. were readily observed, thus indicating considerable electron emission.

The most effective oxides appeared to be a mixture of the yellow and blue oxides, which together appeared as a white deposit. Further, a polarity effect was found when such an oxidized electrode was used in conjunction with clean smooth tungsten as the other electrode; the spark time-lag was low only when the clean electrode was the anode. This result indicated that electron emission from or very near the cathode was the predominating mechanism. On the other hand, the experiments of Howell[4] indicated no polarity effect when using rough electrodes in order to reduce the time-lag, so that on the basis of these results it would appear that the mechanism of electron emission with oxide films is different from that with roughened electrodes. This would be the case for short gaps if the electrons were drawn through the oxide films by intense microscopic electric fields set up by positive charges located on the upper surface of the film, as envisaged by Paetov[1], while with roughened electrodes it is possible that photo-ionization can take place throughout the gap due to the photons emitted from minute discharges at the microscopic points on the electrode.



(1) (2)

X-RAY PHOTOGRAPHS OF COPPER POWDER (*a*) FRESHLY FILED; (*b*) SOME MONTHS AFTER FILING.

It is not easy to distinguish these two mechanisms, as in one case of an oxidized electrode which exhibited short time-lags, a micro-photograph taken at a magnification of 500 showed that parts of the oxide stood out in relief above the metallic surface. Presumably, such electrodes could also behave as simple roughened electrodes without any oxide. Hence, it is probable that both mechanisms play a part in producing electron emission, together with auto-electronic emission from any sharp irregularities on the cathode.

F. Llewellyn Jones.

Department of Physics,
University College,
Swansea. Nov. 17.

[1] Paetov, *Z. Phys.*, **140**, 770 (1939).
[2] Druyvesteyn and Penning, *Rev. Mod. Phys.*, **12**, 117 (1940).
[3] Cobine and Easton, *J. Appl. Phys.*, **14**, 321 (1943).
[4] Howell, *Elec. Eng.*, **58**, 193 (1939).

Negative Resistance-Temperature Coefficient of Thin Evaporated Films of Bismuth

In the course of work on vacuum bolometers, it has been noticed that films of bismuth evaporated on to a backing film of celluloid (both with thickness of the order of 1 micron) possessed a negative resistance-temperature coefficient. In order further to study the property, films of bismuth were evaporated on to microscope slides, washed and wiped but not otherwise cleaned. In every case these showed a negative resistance-temperature coefficient, which diminished with increasing thickness of film.

The pressure in the evaporation chamber was about 10^{-3} mm. mercury. It should be noted that mercury vapour was present during the evaporation, as a mercury diffusion pump was used without a trap.

In these circumstances some deposition occurred on the backs of the slides (about 2·5 per cent of that on the front). The values of the coefficient α obtained for the first slide (back and front coats), and for each of four successive coats on the second slide are tabulated below. The values for the second, third and fourth coats separately were calculated from the measurements made of the resistance at each stage, the layers being treated as independent conductors in parallel.

The values of the coefficient obtained from thin films of other metals, evaporated under similar conditions, are added for comparison. The estimated thicknesses for these indicate only their order of magnitude.

Layer	Estimated mean thickness (microns)	α ($°C^{-1} \times 10^{-4}$)
Bismuth :		
1st slide : front	~1	−27·7
back	~0·03	−20·8
2nd slide : front		
Layer 1	1·5	−31·2
1 + 2	3·1	−29·1
1 + 2 + 3	4·7	−23·0
1 + 2 + 3 + 4	6·5	−16·8
2	1·6	−27·0
3	1·6	−13·4
4	1·8	− 8·7
Iron : on glass	~1·5	+19
Nickel : on glass	~1	+16
Lead : on glass	~2	+29
Gold : on celluloid	~2	+11·7

It is clear that such modified values of the coefficient must be regarded in applying theoretical considerations[1,2] to the selection of bolometer materials.

T. J. Tulley.

Physics Department,
The Royal Cancer Hospital (Free),
London, S.W.3. Nov. 1.

[1] Baker, E. B., and Robb, C. D., *Rev. Sci. Inst.*, **14**, 356 (1943).
[2] Amdur, I., and Glick, C. F., *Rev. Sci. Inst.*, **16**, 117 (1945).

Nomenclature of Triterpene Alcohols

In the early literature dealing with the isolation and characterization of triterpene alcohols it is not uncommon to encounter the use of different names for the description of a single substance, and one of the functions which contemporary papers in this field can usefully perform is the straightening out of this confusion and the establishment of an agreed nomenclature. From this aspect, the recent observations of Zimmermann[1] would appear to be somewhat unfortunate. This author, in extension of his valuable generalization which seeks to correlate, for a given plant source, triterpene structure with type of pigment present, describes the isolation from the marguerite of a monohydric triterpene alcohol which, he claims, is identical with a sample of taraxasterol prepared from the chamomile[2]. This claim of identity is made on the basis of melting-points and mixed melting-points of the alcohols and their acetates, and may be regarded provisionally as valid (no analytical or optical rotatory data are given).

Taraxasterol has been known, as Zimmermann points out, by a variety of names, but in publications[3,4] prior to those of Zimmermann this particular name was adopted, for the reason that it was the name given to the substance on the first occasion[5] of its isolation in undoubted purity and adequate characterization.

Zimmermann has apparently not seen the publications[3,4] in question, because he has reverted to the use of the name 'α-lactucerol' for his alcohol, although it has been clearly pointed out that this name, as it occurred in the early literature, was descriptive of mixtures.

It is true that taraxasterol is a triterpene and not a sterol, but there are many cases of substances the names of which end in '-sterol' which are not steroids—lanosterol, to take but one example—and this suffix has long since ceased to carry with it the implication that the molecule of the compound concerned necessarily contains the cholane skeleton.

It is therefore to be hoped that the name 'taraxasterol' will receive general acceptance, on grounds of convention and logic alike, for the designation of this alcohol, which may well be a characteristic triterpene of the Compositæ and may thus become of major importance; and that the use of unsuitable synonyms (α-lactucerol, α-lactucol, anthesterol) will be discontinued.

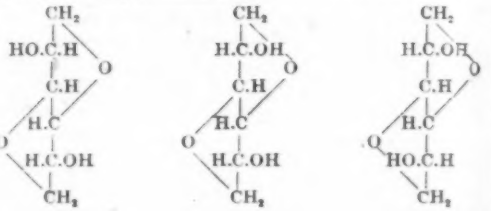
J. C. E. Simpson.

Department of Chemotherapy,
Liverpool School of Tropical Medicine.
Nov. 14.

[1] Zimmermann, *Helv. Chim. Acta*, **28**, 127 (1945).
[2] Power and Browning, *J. Chem. Soc.*, **105**, 1829 (1914).
[3] Burrows and Simpson, *J. Chem. Soc.*, 2042 (1938).
[4] Simpson, *J. Chem. Soc.*, 283 (1944).
[5] Power and Browning, *J. Chem. Soc.*, **101**, 2411 (1912).

Constitution of the Dianhydrides of Sorbitol and Iditol

The hexahydric alcohols mannitol, sorbitol and iditol all form dianhydro compounds on being heated with acid reagents. These compounds and the problem of their constitution have interested us for some time, and the structure of dianhydro mannitol (known as isomannide in the older literature) has already been proved to be that of 1 : 4-3 : 6-dianhydro mannitol[1] (I).



(I) (II) (III)

The elucidation of the structure of dianhydro sorbitol, formed in good yield by the action of acidic reagents on sorbitol, has now been completed by the following synthesis. 3 : 6-Anhydro glucose[2] was converted, by hydrogenation over Raney nickel, into 3 : 6-anhydro sorbitol and this, after selective tosylation followed by acetylation, gave 1-tosyl 2 : 4 : 5-triacetyl 3 : 6-anhydro sorbitol, which, after detosylation and deacetylation, gave dianhydro sorbitol identical with the product of the action of acids on sorbitol. This fact limits the constitution of the dianhydride to two possibilities : (*a*) 1 : 5-3 : 6- and (*b*) 1 : 4-3 : 6-dianhydro sorbitol. (The 1 : 2-3 : 6-ring structure is eliminated because of the stability of the compound to alkaline reagents.) The structures (*a*) and (*b*) were distinguished by synthesis of the dimethyl derivative of (*b*), that is, dimethyl dianhydro sorbitol, by a method which ensures that it is the hydroxyls at C_2 and C_5 that become methylated. This was achieved by using the 2 : 5-dimethyl 3 : 6-anhydro α-methyl glucofuranoside of Haworth, Owen and Smith[3]. The substance was first hydrolysed to the free sugar which, upon catalytic hydrogenation, yielded crystalline 2 : 5-dimethyl 3 : 6-anhydro sorbitol. Treatment with tosyl chloride and acetic anhydride under the appropriate conditions gave 1-tosyl 4-acetyl 2 : 5-dimethyl 3 : 6-anhydro sorbitol; and this, after treatment with alkali, gave 2 : 5-dimethyl 1 : 4-3 : 6-dianhydro sorbitol identical with the product of methylation of the dianhydro sorbitol itself, thus showing it to have the structure represented by (II).

l-Iditol is also readily transformed with acids into dianhydro *l*-iditol, a reaction which has been noted recently by Fletcher and Goepp[4]. By analogy with the dianhydrides of mannitol and sorbitol, dianhydro *l*-iditol would be expected to have a 1 : 4-3 : 6-ring structure. Proof of this has been obtained through a constitutional synthesis of the enantiomorphic compound. 3 : 4-Ditosyl 1 : 2-5 : 6-diacetone mannitol[5] was partly hydrolysed to 3 : 4-ditosyl mannitol. By treatment with sodium methoxide this gave dianhydro *d*-iditol, which yielded crystalline dibenzoyl and dimesyl derivatives. These had identical melting points and specific rotations which were equal but opposite in sign to the corresponding derivatives of the product of acid treatment of *l*-iditol. Since it is clear that a derivative of iditol has been formed from mannitol, Walden inversion must have occurred at both C_2 and C_5; and since anhydro ring formation must also involve these two carbon atoms, the only possible structure for the anhydride of iditol is 1 : 4-3 : 6-dianhydro iditol (III).

A full account of this work, which was supported by the Colonial Products Research Council, will be published elsewhere.

R. Montgomery.
L. F. Wiggins.

A. E. Hills Laboratories,
University, Edgbaston,
Birmingham, 15.
Oct. 24.

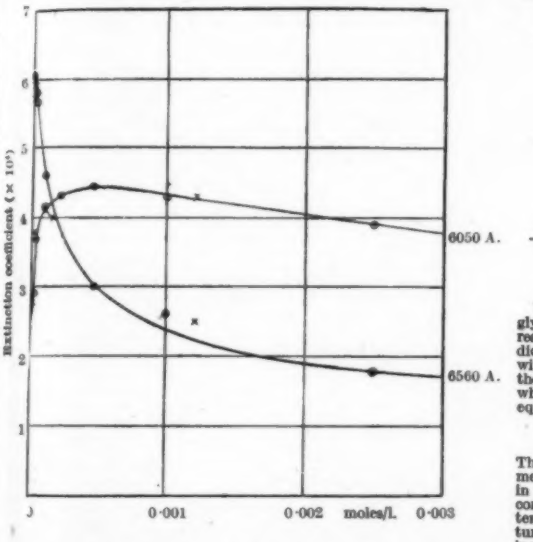
[1] Wiggins, L. F., *J. Chem. Soc.*, 4 (1945).
[2] Fischer, E., and Zach, K., *Ber.*, **45**, 456 (1912); Ohle, H., and Eribach, H., *Ber.*, **62**, 2758 (1929).
[3] Haworth, W. N., Owen, L. N., and Smith, F., *J. Chem. Soc.*, 86 (1941).
[4] Fletcher, H. G., and Goepp, R. M., *J. Amer. Chem. Soc.*, **67**, 1042 (1945).
[5] Brigl, P., and Gruner, H., *Ber.*, **67**, 1969 (1934).

Aggregation of Dyes in Aqueous Solution

We have recently been carrying out work on the aggregation of dyes in solution, and in particular have been interested in comparing the results obtained in a diffusion cell with those obtained by optical methods, since the latter involves no possibility of disturbing the state of dispersion. The optical method was that employed by Rabinovitch and Epstein[1], depending on the change in magnitude and wave-length of the absorption bands on aggregation.

Working with direct dyestuffs, the changes involved were found to be extremely small and the accuracy of measurements required was so high that a reliable estimate of particle-size could not be obtained. Accordingly, attention was turned to the basic dye, methylene blue, which has been shown by Rabinovitch and Epstein to alter very greatly in its absorption spectra with change in concentration, and, as a preliminary step, their work on this dye was repeated.

Rabinovitch and Epstein worked over the concentration range of 2×10^{-3} to 2×10^{-4} moles/litre, and found that on increasing the concentration, the intensity of the absorption band at 6560 A. decreases while a new band appears at 6000 A., increasing in intensity with increasing concentration. They ascribe these two bands to the monomeric and dimeric forms of methylene blue respectively, and by extrapolating the extinction coefficient at these two wave-lengths to infinite dilution and infinite concentration obtain values for the extinction coefficient of monomer and dimer respectively. These results are then used to determine the proportion of the two forms in any solution on the assumption that only monomer and dimer are present, and it is shown that the law of mass action is obeyed over the concentration range tested.



In our work the observed extinction coefficients were higher than those recorded by Rabinovitch and Epstein. The methylene blue used in this investigation was purified by repeated crystallization from alcohol and water and was of 97 per cent purity by titanous estimation and appeared homogeneous when subjected to chromatographic analysis. The concentration range was from $3{\cdot}13 \times 10^{-6}$ to $2{\cdot}5 \times 10^{-4}$ moles/litre, and it was found that the second absorption band (ascribed to dimer) does not merely increase in intensity with concentration, but also shifts continuously towards shorter wave-lengths. Thus, at $2{\cdot}5 \times 10^{-5}$ moles/litre, the peak is at 6050 A., and at $3{\cdot}13 \times 10^{-4}$ moles/litre it is at 5850 A. Consequently, if the extinction coefficient at, say, 6050 A. is plotted against concentration, the curve does not tend to a limiting value at infinite concentration, but passes through a maximum value, as shown in the accompanying graph. From this we conclude that a solution of methylene blue is not a simple mixture of monomer and dimer, but contains higher polymers, especially at high concentration. A similar conclusion may be drawn from the work of Lange and Herre[2], who found an activity coefficient of 0·48 for methylene blue by cryoscopic measurement, and it is further supported by the work of Shepperd and Geddes[3], although these authors put forward an alternative explanation.

A detailed account of this work will be published elsewhere.

T. Vickerstaff.
D. R. Lemin.

Imperial Chemical Industries, Ltd.,
Dyehouse Laboratories,
Hexagon House,
Blackley,
Manchester, 9.
Sept. 26.

[1] Rabinovitch and Epstein, *J. Amer. Chem. Soc.*, **63**, 69 (1941).
[2] Lange and Herre, *Z. phys. Chem.*, **181**, 329 (1937).
[3] Shepperd and Geddes, *J. Amer. Chem. Soc.*, **66**, 2003 (1944).

A Light Reaction with Negative Temperature Coefficient

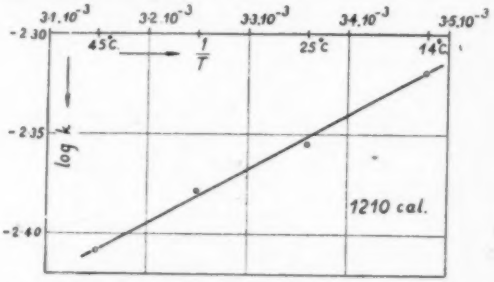
We ascribe a negative temperature coefficient,

$$\frac{\partial k}{\partial T} < 0 ,$$

that is, the temperature quotient is less than one

$$Q_{10} = \frac{k_{T+10}}{k_T} < 1 ,$$

to those chemical reactions the velocity of which decreases with increasing temperature. These reactions have seldom been observed, but some remarkable examples have been realized experimentally. The phenomenon can be explained by supposing a chemical equilibrium preceding the velocity-determining part of the reaction[1]. With increasing temperature this equilibrium is displaced in such a manner that the concentration of one of the reacting components diminishes, and, consequently, the resulting reaction velocity decreases. It is evident that a negative temperature coefficient is more easily attained the *more* the equilibrium depends on the rise of temperature and the *less* the velocity-determining reaction depends on it. The velocity of light reactions is in general nearly independent of the temperature, the activation energy being provided—at least the greater part—by the light absorbed by the system. We believe that, in the field of photo-reactions, if reactions could be found for which the mechanism with a 'preceding equilibrium' and its dependence on the temperature is appropriate, then the negative temperature effect might be observed more frequently than it is.



We have shown by kinetic investigations of the photo-oxidation of glycerol and ethyleneglycol with potassium dichromate that for these reactions, under special experimental conditions (concentration of dichromate and acidity of the solution), a decrease of reaction velocity with increasing temperature takes place. The initial velocity (v) of the reaction, with excess of glycerol, is proportional to the light energy which is absorbed by the dichromate, and we have the following velocity equation :

$$v = k.T_0(1 - e^{-icp}).$$

The values of the velocity constant k, obtained as mean of several measurements with different concentrations of dichromate, are plotted in the accompanying graph, in which the logarithms of the velocity constant are shown as a function of the reciprocal of the absolute temperature. It is evident that k diminishes with increasing temperature and the graph is, according to the theory, a straight line the inclination of which corresponds to an activation energy of 1210 cal.

It can be shown that in the reaction investigated the hydrolysis of dichromate ion represents the 'preceding equilibrium', and that the primary photochemical reaction consists of an electron transition—from one stationary state into another—inside the hydrated dichromate ion, which leads to the formation of the highly oxidizing CrO_3. The reaction mechanism is as follows :

$$(1)\ Cr_2O_7^{--} + H_2O \rightleftarrows 2HCrO_4^- + Q$$

$$(2)\ Cr_2O_7^{--} HOH + h\nu \rightarrow HCrO_4^- + OH^- + CrO_3.$$

The CrO_3 formed in this manner oxidizes glycerol, or other oxidizable substance present, during which process chromium compounds in a lower oxidizing state are formed, as follows :

$$2CrO_3 \rightarrow Cr_2O_3 + 3O \text{ or } CrO_3 \rightarrow CrO_2 + O.$$

The heat of reaction (1) has not until now been directly measured, though Viktor La Mer and Chester L. Read[2] calculated it from measurements of the heat of neutralization of sodium dichromate with sodium hydroxide as $Q = -13{,}640$ cal./mol. They used an equilibrium constant for the above reaction (at 25° C.) quoted from S. M. Sherrill[3], namely, $K_c = [HCrO_4^-]^2/[Cr_2O_7^{--}] = 0{\cdot}019$, which seems to be too small. If we recalculate La Mer and Read's results with the constant $K_1 = 0{\cdot}05$, found by R. H. Stokes, J. M. Wilson and R. A. Robinson[4], a heat of reaction $Q = -1{,}186$ cal./mol. results, in good agreement with the activation energy determined from our kinetic measurements. This new calculation gives also a value for the heat of dissociation of hydrochromate ion ($HCrO_4^-$) of $-7{,}860$ cal., a value of the same order as that calculated from the temperature dependence of the dissociation constant ($-6{,}772$ cal.). La Mer and Read's value of the heat of dissociation using the 'old' constant is not only different but also of the opposite sign (+ 780 cal.).

Our experiments, which we consider as a proof of the above reaction mechanism, will be communicated in detail elsewhere.

K. WEBER.
S. ASPERGER.

Physico-chemical Institute,
Engineering Faculty,
University, Zagreb.
Oct. 12.

[1] Skrabal, A., "Homogenkinetik", 211ff. (Dresden: Th. Steinkopff-Verl., 1941). Griffith, R. O., and McKeon, A., "Photo-Processes in Gaseous and Liquid Systems", 660 ff. (London: Longmans, Green, 1929).
[2] *J. Amer. Chem. Soc.*, **52**, 3098 (1930).
[3] *J. Amer. Chem. Soc.*, **29**, 1641 (1907).
[4] *Trans. Faraday Soc.*, **37**, 566 (1941).

Are there Triflagellate Gametes in the Foraminifera?

THE great diversity of form shown by the gametes of the Protozoa is well known. Even among the Foraminifera they may be amœboid, for example, *Patellina*[1], *Spirillina*[2]; or flagellate, at least at one stage. Of the latter, to mention only one feature, some may have but one flagellum as in *Gromia*[3-5], but in the more typical Foraminifera they are usually represented as having two; for example, *Trichosphærium*[6], *Iridia*, *Planorbulina* and others[6], *Polystomella* (*Elphidium*)[7-9], "Tretomphalus"[9] (perhaps, as Myers suggests, a pelagic phase of a species of *Discorbis*). In the case of *Discorbis* (*Discorbina*), we have the very convincing account by Føyn[10] of a life-cycle for *D. vilardeboana* which includes biflagellate gametes of a similar kind; but Myers[11] has also described and figured *triflagellate* gametes in *D. patelliformis* in California. As he himself remarks, "three is a most unusual number" for the flagella of gametes of either plant or animal organisms; indeed it is unique.

There are other unusual features about these gametes in the living state: coloured inclusions suggestive of solid ingested food, "a slight notch, suggestive of a cytopharynx", and, most striking of all, their persistence in activity for periods up to 34 days in 'multiple tests' (that is, associated individuals enclosed in a common covering, a condition preceding sexual reproduction) collected from coralline pools and kept with the rest of the finer sediment washed off the weed, in finger-bowls of "sea water recently removed from the sea". While Dr. Myers was writing his paper at Plymouth in 1939, he very kindly showed me a preparation of these flagellates, including at least one of the specimens reproduced in his Pl. II, Fig. 16 of ref. 11, where, as he says, the "false cytopharynx does not show clearly". But, bearing in mind the old warning, sounded by Lister fifty years ago and recently emphasized by Kofoid and by Myers himself (see p. 223 of ref. 11), against careless acceptance of organisms observed in the tests of Foraminifera as stages in their life-history, I could not help noticing, when I had occasion the other day to look up some papers on marine flagellates, that there are records[12] of one or two species of free-living triflagellate salt-water organisms which agree well, so far as the very sketchy description goes, with Myers' 'gametes' of *Discorbis patelliformis*; and that these readily survive in the gathering and may be cultivated with ease. Two species of *Triflagellum*, collected in salt workings and salt lakes in various parts of the world, were cultivated in Holland, at Leyden, in the Botanical Institute of which the director, Prof. L. G. M. Baas-Becking, had previously found one at least at Marina in *California*. Does this observation solve the problem of the existence of these most peculiar triflagellate gametes in one species of *Discorbis* in California, while another species, in Europe, forms gametes of a more usual biflagellate kind?

MARGARET W. JEPPS.

University, Glasgow.
Nov. 28.

[1] Myers, Earl H., *Bull. Scripps Inst. Oceanography*, **3**, 15 (1935).
[2] Myers, Earl H., *J. Roy. Micro. Soc.*, **56** (1936).
[3] Lwoff, André, *Trav. Stat. Wimereux*, **9** (1925).
[4] Jeppe, Margaret W., *Quart. J. Micr. Sci.*, 70 (1926).
[5] Schaudinn, F., *Anh. Abh. K. Preuss. Akad. d. Wiss.* (1899); Schaudinn's "Arbeiten", 31.
[6] le Calvez, Jean, *Arch. Zool. Exp. et Gén.*, 80 (1938).
[7] Myers, Earl H., *Proc. Amer. Phil. Soc.*, 85 (1942).
[8] Jeppe, Margaret W., *J. Mar. Biol. Assoc. U.K.*, 25 (1942).
[9] Myers, Earl H., *Stanford Univ. Pub. Biol. Sci.*, **9**, 1 (1943).
[10] Føyn, Bjørn, *Bergens Mus. Årb. Nature. Rekke*, 2 (1936).
[11] Myers, Earl H., *J. Mar. Biol. Assoc. U.K.*, 24 (1940).
[12] Ruinen, Jacoba, *Arch. J. Protistenk.*, 90 (1938).

Obligate Parasitism

THE phenomenon of obligate parasitism is well known among the fungi, particularly the rusts and the powdery mildews. That the rust derives its nutrients from the host has been accepted *a priori*, since no other source of food for the fungus was possible. Yet the fact that the nutrients from the soil were furnished to the fungus through the plant system has not been demonstrated. Radio-phosphorus, P^{32}, which is not changed by the plant, furnished a simple means of showing that the nutrient actually comes through the host plant.

Seeds of Little Club wheat were germinated on moist filter paper. When the first true leaf pierced the coleoptile, some seedlings were placed into Hoagland's nutrient solution and others into a similar solution in which the radioactive potassium dihydrogen phosphate has been substituted for the normal form P^{31}. The plants were inoculated with spores of *Puccinia graminis tritici* race 56, and incubated in a moist chamber for 36 hours. The wheat was grown under illumination of a 200-watt Mazda lamp and was kept at 20° ± 2° C. during the entire experiment.

Rust spores were collected twelve days later and analyses made of the substrate, leaves and spores. The leaves and spores were prepared for assay by first drying the samples to constant weight and then digesting them, the former in concentrated hydrochloric acid and the latter in *aqua regia*. 0·1 ml. samples were placed in the well of a depression slide and then dried at 50° C. Determinations of radioactive phosphorus were made by placing the slide under a Geiger tube and the counts were recorded. Three replicates were made for each determination, and all results in the accompanying table are an average of these values, and except where otherwise indicated, are reported as counts per gram of dry tissue. All determinations for radioactive phosphorus were made on the same day and the results were converted by means of a 'decay curve' to values for radio phosphorus on the day samples were taken.

Results of the analyses show the presence of P^{32} in the nutrient solution (P^{32}), in the leaves of the wheat and in the spores of the rust collected from these plants. No radioactivity was found in wheat seedlings grown in the normal nutrient solution (P^{31}), nor in the spores obtained from them. Radiographs also revealed the presence of P^{32} in the leaves and in the spores collected from plants grown in the P^{32} nutrient solution.

PRESENCE OF PHOSPHORUS IN COMPONENTS OF OBLIGATE PARASITISM COMPLEX

Material analysed[1]	Counts of radioactivity per gram dry weight
Nutrient solution (P^{31})	0[2]
Nutrient solution (P^{32})	5,900[2]
Leaves (P^{31})	0
Non-inoculated leaves (P^{32})	20,400
Inoculated leaves (P^{32})	21,067
Spores (P^{32})	13,200

[1] Symbols P^{31} or P^{32} denote the type of phosphorus contained in the nutrient solution used for growing the host plant.
[2] Counts per ml. of nutrient solution.

Since no radioactivity was present in the check plants, grown in normal Hoagland's solution (P^{31}), all activity of the wheat grown in the P^{32} solution was due to the radio-phosphorus of the substrate. The presence of this tracer element in the plant and its subsequent appearance in the rust spores demonstrated that the fungus obtains this element from the host plant. Only one component in the chain is unaccounted for, the presence of the phosphorus in the vegetative mycelium of the fungus. The separation of this mycelium from the host tissue in amounts sufficient for analyses is almost impossible, and we can assume that since the spores contained radioactive phosphorus, that element must have been derived from a mycelium.

Thus it is apparent that in the parasitic relationship between the rust and the wheat plant the host absorbs the phosphate ions from the substrate, and transfers them to the leaves and other parts of the plant, from which they are absorbed by the hyphæ and finally found present in the spores.

This study is not a regular station project of the Agricultural Experiment Station here, but represents our own interests in this field.

JAMES MONROE GARNER.
DAVID GOTTLIEB.

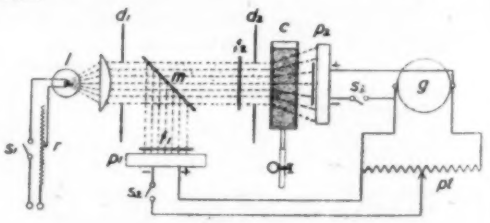
Newark, Delaware.

University of Delaware,
Newark, Delaware.
Oct. 26.

Simple Photometric Method of Determining the Rate of Bacterial Growth

THE Rideal-Walker and other widely employed methods of evaluating disinfectants involve determining whether or not growth of bacteria occurs in sub-cultures taken from serial dilutions under defined conditions. They, therefore, necessitate a yes or no answer and are extremely inelastic, so that the data obtainable are strictly limited. Experiments have been designed to overcome these disadvantages and it is believed that the apparatus employed should be applicable to a number of problems in a considerably wider field.

A compensated photometric circuit has been devised for determining relative bacterial densities. It is modified from that of Libby[2] and is simpler than those of Pulvertaft[3] or Alper and Sterne[4]. Light from a 12-volt 24-watt projector bulb *i* rendered parallel by lenses and baffles, d_1, d_2, falls on an optically flat glass plate, *m*, which reflects a part of the beam on to a photocell, p_1. The transmitted portion of the beam passes through the bacterial culture which is contained in a flow-through type of cell, *c*, having two optically flat facing sides, and thence reaches a second photocell, p_2, the centre of which has been rendered inoperative by the use of a baffle having a diameter fractionally greater than the diameter of the parallel beam employed. By this means the undeflected light is prevented from reaching the sensitive surface of p_2, which responds only to light scattered by the bacterial growth present in the culture under examination. The compensating nature of the electrical circuit is clear from the diagram, *g* being a reflecting galvanometer and *pt* a potentiometer calibrated 0–100.



To effect a measurement, the transmitted beam is first cut off by the insertion of a card at f_3, the potentiometer adjusted to some chosen reading, and the light adjusted by means of r to give a definite galvanometer deflexion. When the blocking card is removed, any light scattered by the sample in c falls on the second photocell, p_2, and causes an opposing deflexion of the galvanometer. The potentiometer is then readjusted to produce a null-point reading, and the degree of this readjustment is a measure of the scattered light and thus of the bacterial density.

The sensitivity is widely variable—absolutely by altering the resistance, r, in the lighting circuit, and comparatively by inserting neutral-tint filters in the positions marked f_1 and f_2. Presence of a filter in the reflected or transmitted beam will respectively increase or decrease the sensitivity.

Apart from its use in the evaluation of disinfectants, the apparatus has been used by me to determine how the rate of bacterial growth is affected by (*a*) time of incubation, (*b*) varying the composition of the medium, (*c*) variation in *p*H and (*d*) variation in the size of the inoculum.

Details of the apparatus and of some of these applications will be published elsewhere.

N. V. NEEDHAM.

Cooper Technical Bureau,
Berkhamsted.
Oct. 3.

[1] Alper, T., and Sterne, M., *J. Hyg. Camb.*, **33**, 497 (1933).
[2] Libby, R. L., *J. Immunol.*, **34**, 71 (1938).
[3] Pulvertaft, R. J. V., *J. Hyg. Camb.*, **33**, 245 (1933).

Variation in the Rate of Growth of the Milk-Fish (*Chanos chanos*)

Chanos chanos (Forskal) is a marine fish which can be easily acclimatized to fresh water and hence it is recommended for culture in both brackish water and fresh water. (The technique of acclimatizing and conditioning milk-fish fingerlings for transporting and stocking in fresh waters has been perfected at Krusadai.) The fish, with mullet, are reared at the Krusadai marine fish farm.

Fingerlings of *Chanos* measuring 3–4 in. long were collected from shallow creeks near Krusadai and were introduced in June 1944 into three different waters: (1) the marine fish farm at Krusadai; (2) a brackish water tank at Mandapam Camp; and (3) a freshwater tank, Lakshmana Theertham, at Rameswaram. The tank at Rameswaram is larger and deeper than the other two; both tanks are spring-fed as well as rain-fed and have no connexion with any other piece of water, whereas the marine fish farm at Krusadai has a channel connecting it with the sea and consequently the water is affected by tidal action.

At the marine fish farm, the maximum length of milk-fish observed was 10·2 in. in November 1944, though the average was less than 9·6 in. No further growth was noted by the last week of June 1945.

In the brackish water tank at Mandapam Camp, fingerlings had by September 1944 grown to an average length of 10·8 in., that is, a growth of 7·8 in. in three months; one specimen caught in March measured 1 ft. 3½ in. and in July it was 1 ft. 4 in. in length.

In Lakshmana Theertham, a specimen captured in September 1944 measured 12½ in., showing a growth of 9·5 in. in three months. On examination in November 1944, the average length was 16·5 in. Specimens of milk-fish caught in the last week of June 1945 had reached 2 ft. in length.

Struck by the remarkable variations noticed in the rate of growth of milk-fish belonging to the same stock in three different waters, investigations on the hydrography of the waters were commenced as early as September 1944. At the marine fish farm at Krusadai the water was of specific gravity 1·0131–1·0279; surface temperature 27·0°–32·2° C.; hydrogen ion concentration 8·3–8·4. At Mandapam Camp, the surface temperature and specific gravity of the water were 29·4°–31·0° C. and 1·009–1·0123 respectively; the *p*H value was high in June 1945 when it was 8·8. Surface temperature and specific gravity of the Lakshmana Theertham at Rameswaram were 30·5°–32·5° C. and 1·000; *p*H was 8·0.

The preliminary study of the plankton of the three waters showed that in the farm at Krusadai the quantity of plankton was poor, though it represented a greater variety of organisms; in the tank at Mandapam Camp the plankton is comparatively rich, having a large percentage of copepods; and in Lakshmana Thirtham it is very rich and represented by copepods, daphnids, ostracods and algæ which were found to be the main diet of the fish in the last-mentioned tank.

The large fish examined from all three waters had only traces of gonads, thus indicating the absence of suitable conditions for spawning. The hydrobiological variations of these waters are being studied in greater detail and will be published shortly.

From this work, the rate of growth of *Chanos chanos* is a maximum in the fresh water, attaining a length of 2 ft. in about one year; it is less in brackish water, and much less in confined sea water. Growth is rapid in the first few months. The fish grow well in waters rich in zooplankton. The accompanying table gives a comparative idea of the rate of growth of the milk-fish in the three waters and also the value of the fish after a period of one year.

Locality	No. of *Chanos* fry introduced	Length when stocked	Length after 1 year	Approximate marketable value (rupees)
Marine Fish Farm at Krusadai	500	3·4 in.	10·2 in.	0–8–0 per fish
Tank at Mandapam Camp	1000	3 in.	16 in.	1–8–0 „ „
Lakshmana Theertham at Rameswaram	200	3 in.	24 in.	2–8–0 „ „

The remarkable growth of the fish in fresh water and their high market value show their suitability for profitable culture in fresh waters. The Madras Fisheries Department, encouraged by these observations, have supplied 2,500 *Chanos* fingerlings for the Mandapam Camp tank and about 8,000 for stocking fresh waters in Madras, Madura and Ceylon.

This note is published by permission of the Director of Industries and Commerce, Madras.

K. CHIDAMBARAM.
M. MUKUNDAN UNNY.

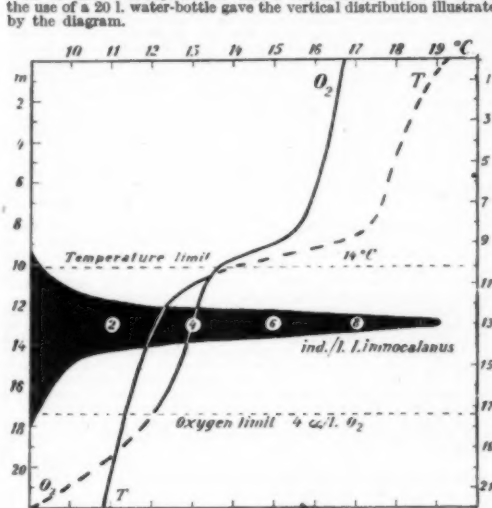
Krusadai Biological Station,
Gulf of Mannar,
South India.
Oct. 31.

REFERENCES:
Administration reports of Madras Fisheries Department.
Devanesen, D. W., and Chacko, P. I., *Proc. Nat. Inst. Sci. Ind.*, 9.
Ganapathy, S. V., *Proc. Ind. Acad. Sci.*, **17** (1943).
Adams, Wallace, Montalben, H. R., and Martin, Clare, *Phil. J. Sci.*, **47**, No. 1 (1932).

The Ecological Niche

A SUPERB example illustrating the ecological niche is afforded by the distribution of the plankton copepod *Limnocalanus macrurus*, a freshwater relict derived from the marine arctic species *L. Grimaldii*. The animal has an upper temperature limit of 14° C., and a lower limit of dissolved oxygen of 4 c.c./l. oxygen. In the lowland lakes beyond the arctic region it will therefore during summer stagnation live between the upper waters which are too warm and the lower waters which are too depleted of oxygen.

In the lake Steinafjord near Oslo a combination of net hauls and the use of a 20 l. water-bottle gave the vertical distribution illustrated by the diagram.



The relative optimum in the circumstances is evidently at about 12° C. and 4·5 c.c./l. oxygen, but the massing of the animals at the depth of 13 m. may also be due to their grazing on dead plankton as near the thermocline as possible.

Limnocalanus thus may be said to live between the 'devil and the deep sea'.

KAARE MÜNSTER STRØM.

Department of Limnology,
University, Blindern,
Oslo.
Sept. 27.

Potato 'Bolters': an Explanation Based on Photoperiodism

ATTEMPTS to solve the problem of the 'bolter' condition in domestic potato varieties have appeared from time to time in these columns. Thomas[1], for example, demonstrated that bolters differ from normal plants by the presence of a small supernumerary chromosome, though Carson and Howard[2] have found no differences between 'bolter' and normal in this respect. They showed, however, that the 'bolter' condition could be transmitted to its progeny when crossed with normal plants.

When working on the effect of differing lengths of day on South American potatoes in 1943[3], I was struck by the apparent similarity

of growth between bolters on one hand and short-day adapted potatoes when grown under long day on the other. It seemed possible that the bolter condition might be due to one or more gene mutations controlling the photoperiodic response, changing the normal long-day adapted domestic potato variety into one more adapted to short days as are most of the Andean potato varieties from which our own potatoes were originally derived.

As is well known, the 'bolter' differs from the normal in the direction of 'wildness', that is to say, it possesses certain characters typical of wild potatoes, chief among them being long stolons, later maturity, more abundant flowering, taller growth, especially in the low-growing first earlies, and other characters. Now, these features are just what are to be found in varieties of *Solanum andigenum* when grown under the long summer days in Britain (see Driver and Hawkes[3]). The tetraploid Andean potato is adapted to the short twelve-hour days of the tropics where most varieties possess short stolons and moderately quick maturity. When grown under long days, however (*loc. cit.*[3], p. 28), the majority form very long stolons, take much longer to mature and grow generally more than twice as tall as equivalent plants under short day (*loc. cit.*[3], pp. 30–31).

The inference that may be drawn from this is that in many cases stolon length and time of maturity are due to the photoperiodic response of the potato to any given condition of length of day. The parallel between the Andean potatoes and 'bolters' would seem to be very close, the latter presumably differing from the normals in their adaptation to short days just as *S. andigenum* differs from *S. tuberosum* chiefly in this respect. 'Bolters' arise from normals in one or two stages by quite sudden change, and it would seem possible that they might be due to the sudden mutation of one or more relatively unstable genes controlling response to day length.

The following preliminary experiments were designed to check this hypothesis.

Tubers of the potato variety King Edward, both normals and 'bolters', were grown under long and short days, the latter being of about 10 hours duration. All plants were grown in insect-proof glasshouses.

The 'bolter' and normal plants under short days showed very little differences in respect of height of plants, and *in all cases* the stolons were very short, less than 0·5 in. long. On the other hand, under long-day conditions the bolters were considerably taller than the normals and the stolons were relatively very long. Thus the normal plants varied from 39–42 in. in height while the 'bolters' were from 62–64 in. high. The normal plants under long day possessed stolons of less than 0·5 in. Of the four bolter plants under long day the first had stolons of 15, 8, 17·5 in., the second of 12, 9, 6 in. and the third 2·5, 2·5, 2 in. respectively. The fourth bolter plant was of particular interest in that it had been mistakenly given twenty-seven short days and was then removed to the long day house, where it received 102 long days. At the end of this time, of course, the day length was much shorter and the plant had reached maturity. On harvesting, it showed a small group of three rather old soft tubers clustered at the base of the stem on stolons of not more than 0·25 in. long; these would have been formed under the first period of twenty-seven short days. In addition, there were three tubers on stolons of 2·5, 3 and 7 in. respectively that had obviously been produced during the period of long days.

Maturity relationships were not so clear cut since the short days given were less than twelve hours, and under these conditions both 'bolters' and normals matured after ninety-nine days. Under long days the normals matured somewhat earlier than the bolters, but unfortunately it was not possible to take records of this. The 'bolters' reached maturity in about 144 days.

These preliminary experiments, although not on a sufficiently large scale to be capable of statistical analysis[4] (only sixteen plants in all being grown), nevertheless give a very definite indication that the bolter condition is due to a genetical alteration of some nature, converting the plant from a long-day to a short-day type. Under short days the 'bolter' grows normally, but shows various 'wild' characteristics under long days, as with the short day adapted *S. andigenum* when grown under the long summer days of temperate latitudes.

It is hoped in 1946 to be able to continue the experiments on a much larger scale and with several varieties from different maturity groups.

J. G. Hawkes.

Imperial Bureau of Plant Breeding and Genetics,
School of Agriculture,
Cambridge.
Nov. 15.

[1] Thomas, P. T., *Nature*, **155**, 242 (1945).
[2] Carson, G. P., and Howard, H. W., *Nature*, **154**, 829 (1944).
[3] Driver, C. M., and Hawkes, J. G., Imperial Bureau of Plant Breeding and Genetics (Cambridge, 1943).

Incidence of Defective Colour Vision

Difference of opinion exists as to the incidence of defective colour vision among the male members of the population. Wright[1] has given a figure of 8 per cent, and the value of 7·95 per cent of v. Planta[2] and 8·01 per cent of Waaler[3] agree very closely. Vernon and Straker[4] gave a lower figure of 7·49 per cent for examinations carried out for entrance to the Navy; the testing in the Navy was done by 'Wrens' working in different centres. In Germany, Schmidt[5] gives 7 per cent for males and 4 per cent for females from the examination of 20,000 persons.

In the Royal Air Force, among 16,180 candidates for air crew (young healthy men aged 18–30 years) 1,068 (6·63 per cent) were found to have defective colour vision. These examinations were all carried out by the same person working at different times in London, Oxford, Birmingham, Blackpool, Belfast and Doncaster, and the criteria for defective colour vision remained the same throughout.

The procedure in the Royal Air Force has been to classify colour defectives, not according to the nature of the colour defect, but according to whether the defect was such as to render the candidate unsafe in the air. To achieve this end, all candidates were shown the Ishihara Plates in random order in good daylight (northern window). Those who made more than one or two slips were further tested on the Giles Archer Colour Perception Unit (Aviation Model); those who made no mistakes on this lantern were passed as normal; those who made slight errors such as calling white amber, or amber white, were classed as safe, and those who made more serious errors were classed as unsafe. 109 (10·2 per cent) of the 1,068 defectives were in the safe category.

It is readily appreciated that this method is entirely practical, and that by the use of some form of anomaloscope a higher percentage of colour defectives would be obtained. There is, however, sufficient evidence to show that the incidence of defective colour vision is not less than 6·63 per cent, and that by the more detailed examination of Wright, the figures quoted by him, and by the other authors, are not far from the true incidence.

John Grieve.

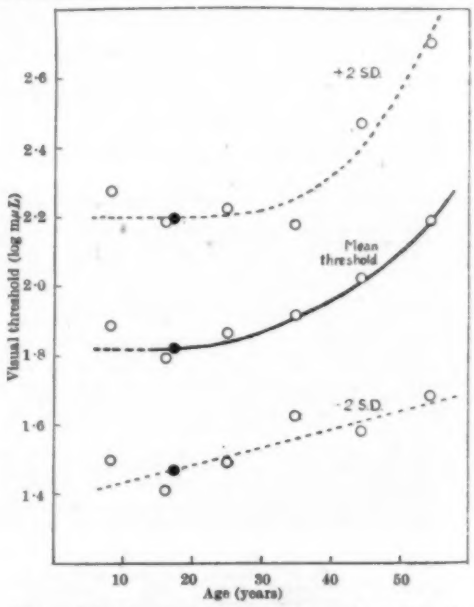
R.A.F. Officers' Mess,
Worksop.
Notts.
Nov. 24.

[1] Wright, W. D., "The Measurement of Colour", 52 (London: Hilger).
[2] von Planta, P., *Arch. Ophth.*, **120**, 25 (1928).
[3] Waaler, G. H. M., *Z. Indukt. Abstamm. und Vererblehre*, **45**, 279 (1927).
[4] Vernon, P. E., and Straker, A., *Nature*, **152**, 690 (1943).
[5] Schmidt, I., unpublished data (1945).

Relation Between Dark Adaptation and Age

It is well known that the night vision of most elderly persons is poorer than that of the young. This is believed to be due mainly to progressive senile changes, such as yellowing of the ocular media, by which an increasing fraction of the light entering the eye is absorbed before reaching the retina. Any test of night vision, which makes use of the normal range of dark adaptation of healthy persons as a standard by which to evaluate abnormal states, requires to take into account this progressive deterioration with advancing age. Since little information is available on this matter, the following data, obtained in the course of investigations on vitamin A deficiency during 1941–42, have been analysed with reference to the age of the subjects.

The measurements are of the final stable dark-adapted visual threshold, obtained with the Wald-Steven adaptometer[1,2], and adjusted to a standard pupil diameter of 5 mm. The sample of 628 persons is composed of families investigated during nutritional surveys in Oxford and Accrington, students at the Universities of Oxford and London and at Heythrop Jesuit College, and children at an orphanage in Oxford. No cases are included of night blindness due to any diagnosed cause.



The sample has been treated in six 10-year age classes, from 10 and under to 51 and over, and the results of analysis are presented in the table and figure. With the exception of the youngest, there is a progressive deterioration of the mean performance of each successive age-class of about 0·05 log units in 10 years up to about forty years of age, increasing in more elderly persons. The data are too few to permit more detailed analysis of the older classes. The relatively poor performance of the youngest class is probably due to the difficulty in obtaining accurate measurements from young children, and should not be taken to indicate that the night vision of children is worse than of young men and women.

The variance around the means of the age-classes provides an estimate of the expected range of visual threshold of normal persons of different ages. This is expressed in the figure and table as the limits enclosed within plus and minus twice the standard deviation from the mean of each age class. It is seen that both the mean and its variance increase with age, though the lower limit of the range rises more slowly than the higher. The lower limit in fact represents the physiological optimum of the visual threshold measured under these conditions, and the progressive deterioration of the older age-classes is mainly due to the increased frequency of poor dark adaptation among elderly persons. Dark-adaptation tests of this type therefore are less sensitive for detecting pathological states in older than in younger persons.

Age class	No. of subjects	Mean age of class	Mean visual threshold ± standard deviation (log. $m\mu L$)	Normal range expressed as mean ± 2 × S.D. (log. $m\mu L$)
1. 10 and under	79	8·3	1·872 ± 0·193	1·48 to 2·26
2. 11–20	258	16·2	1·777 ± 0·193	1·39 to 2·17
3. 21–30	139	25·1	1·844 ± 0·146	1·47 to 2·21
4. 31–40	89	34·7	1·889 ± 0·137	1·61 to 2·16
5. 41–50	43	44·5	2·007 ± 0·222	1·56 to 2·45
6. 51 and over	20	54·4	2·170 ± 0·256	1·66 to 2·68
	628			
Classes 1, 2 and 3 pooled	476	17·5	1·812 ± 0·182	1·45 to 2·18

The units of brightness in which these data were measured hold true for the conditions of this particular test only. The relative differences between the age-classes, however, are valid for all tests of this type, and provide a scale for defining the normal limits of visual threshold for persons of various ages. It is suggested that the best estimate of the normal range of persons less than thirty years of age is obtained by combining the data of the three youngest age classes (see bottom of table), the differences between the means of which do not reach the 5 per cent level of significance. The range of visual threshold expected at any greater age may then be expressed by adding a correction to this value.

D. M. Steven.

Department of Zoology,
University of Edinburgh.
Nov. 15.

[1] Wald, G., *J. Opt. Soc. Amer.*, **31**, 235 (1941).
[2] Steven, D., and Wald, G., *J. Nutrit.*, **21**, 461 (1941).

Need for the Development of Tropical Ecological Stations

The letter of Dr. V. J. Chapman and his associates in *Nature* of November 24, 1945, will be warmly welcomed by all who, like myself, have endeavoured to contribute to the study of tropical ecology. The necessity of fundamental ecological knowledge to the progress of forestry and agriculture, in fact to any rational scheme of land utilization in the tropics, is so clear that it need not be further argued; it is also evident that much of our current teaching in ecology, as well as in other branches of biology, would be set in a truer perspective if more consideration were given to tropical vegetation and the conditions for plant growth in the tropics. As van Steenis[1] has pointed out, in attempting to study vegetation and to arrive at generalizations which will serve to relate the various plant communities to one another, it would be more logical to begin with the floristically rich vegetation of the tropics than, as we now do, with the impoverished vegetation of northern Europe and North America. W. H. Brown[2] wrote in much the same strain in 1919.

With regard to the practical proposals by Dr. Chapman *et al.*, there are a few comments I should like to make:

(1) The authors complain that the ideas on tropical ecology which they gained at British universities were faulty. This is scarcely surprising when the few references to tropical vegetation which occur in university courses are mainly derived from works as long out of date as the English edition of Schimper's "Plant Geography". There is a great need for at least some of our universities to develop, probably at the post-graduate level, introductory courses in tropical botany, including ecology; such courses would be valuable both as a preparation for men about to take up posts in tropical countries and as refresher courses for those already working there.

(2) I should like to support the plea for frequent exchanges of workers between the forestry departments in the Colonies and the home universities, but exchanges between different colonies would be even more valuable. My own researches[3] have demonstrated that plant communities of similar habitats in countries as far apart as Borneo and British Guiana may be remarkably similar in both their structure and their ecological relationships. Such similarities are only apparent to those who have had experience of more than one tropical region. The man whose experience is limited to one colony or region will be unable to distinguish the general from the purely local features of the communities he studies.

(3) The writers of the letter rightly urge the need for writing more papers on tropical problems, but they do not consider where such papers are to be published. Papers on tropical ecology at the present stage of its development are largely descriptive and therefore necessarily long. Even when the present stringency in paper and printing has passed, the editors of such journals as the *Journal of Ecology* may be unwilling to publish a large number of papers on tropical ecology, however excellent, because many readers may not be interested in the subject. There seems a strong case for some kind of subsidy from the Colonial Office or the Colonial governments which would enable long papers to be published as supplements to established journals.

(4) The need for a central ecological bureau analogous to the Imperial Agricultural Bureaux is undoubted; it was suggested in 1940[4]. Whether such a bureau would be best sited in India seems to me less certain.

(5) Dr. Chapman and his friends do not seem to appreciate the extent to which the advance of tropical ecology must be dependent on the further development of systematic botany in the tropics. It is undoubtedly true that much valuable ecological work can be done without anything approaching a complete list of the species in the communities studied; it is also true that an improved system of classifying tropical plant communities can only be arrived at by paying more attention than at present to their structure and physiognomy and less to their floristic composition, but with the statement that "the description of tropical forests in terms of detailed floristics or quadrats is of very little value" I emphatically disagree. To take only one example: only by a study of floristic composition in relation to the factors of the environment can we deal with such problems as the causes underlying the dominance of single species in certain types of tropical forests, a problem of obvious importance to the forester who is trying to grow a pure crop of one or a few economically valuable species of trees. The difficulties in the way of accurate floristic studies are great, but they are not insuperable. The writers of the letter are not helping to remove them by suggesting that "when the ecologist or forester arrives in the tropics he will find that one or other department has a trained systematist who can prepare any list he desires". Certainly there are some excellent systematists in the Colonies, but is there even one Colony with a 'flora' really adequate by modern standards, or where the systematics of even the commoner trees are sufficiently known, even to the 'trained systematist'?

(6) It will be generally agreed that one or more tropical field stations for ecological research are greatly needed. The value of such stations, especially to visiting workers from home universities, is sufficiently shown by the important scientific results obtained at the laboratories at Buitenzorg and Tjibodas in Java, until recently the only stations of their kind. The value of such stations would be much increased if samples of undisturbed natural vegetation in their neighbourhood could be set aside as nature reserves. It is often not realized that the forest reserves in the Colonies are only reserves in the sense that they are protected against unregulated felling of timber. The area of virgin tropical rain forest and of other climatic climax communities in the tropics is rapidly decreasing and it is essential in the interests of ecological research, if for no other reason, that samples of them should be preserved before it is too late.

P. W. Richards.

Botany School,
Cambridge.
Nov. 28.

[1] van Steenis, C. G. G. J., *Tectona*, **30**, 625 (1937).
[2] Brown, W. H., "Vegetation of Philippine Mountains" (Manila, 1919), p. 43.
[3] Richards, P. W., *J. Ecol.*, **24**, 1, 340 (1936).
[4] Richards, P. W., Tansley, A. G., and Watt, A. S., *J. Ecol.*, **28**, 224 (1940).

In *Nature* of November 24, a letter appeared concerning the need for the development of tropical ecology, with a suggestion for co-operation from tropical foresters. My experience in Malaya during the last sixteen years tells me that this appeal is only a small part of a much greater problem and no way to succeed. The need is for the development of tropical biology in every branch by 'pure', not applied, biologists in proper biological institutes in the tropics.

It seems absurd to write such an obvious thing, but consider botany. From the arctic circle to the equator, the abundance and variety of plants increase in geometrical proportion. Their science has grown up between latitudes 40° and 60° N., and botanical text-books omit the majority of them. No other science, perhaps, has become so unbalanced through the neglect of its tropical aspect.

But where can a British botanist learn tropical botany? In all the extent of our tropical Colonies and Protectorates there is only one botanical department: the Gardens' Department of the Straits Settlements; and it cannot be said that any botanist other than those of its minimal staff has ever been to its Botanic Gardens for research. No botanist, moreover, could be found to relieve the director or myself, after our struggle to preserve the Department during the Japanese occupation. Indeed, it may now lose its status through apathy.

In the case of zoology, where is there a 'zoo' in a British Colony, and how many marine aquaria? Not a zoologist, either, could be found to relieve those of us at Raffles' Museum who struggled to maintain it during the occupation.

One must conclude that, in consideration of its enormous territorial advantages, British science has done little to develop tropical biology.

It must be obvious that tropical biology cannot be studied in temperate institutes any more than temperate biology can be studied at the equator. Somehow or other, we must not only establish tropical biological institutions but also secure large tropical nature reserves under their immediate direction so that tropical biology can flouris and tropical life can be preserved. British science should lead, yet the neglect of Singapore is to me a sad indication of the times—a weary struggle against petty finance and indifference; too remote for help from Great Britain.

E. J. H. Corner.
(Assistant Director of Gardens, Straits Settlements.)

15 The Park,
Gt. Shelford,
Cambridge.
Jan. 26.

ZAVARITZKY'S PETROLOGICAL METHODS

By S. I. TOMKEIEFF

MICROSCOPICAL petrology was first studied in Russia some eighty years ago and, reinforced by chemistry and physical-chemistry, made rapid progress, largely through the genius and the untiring efforts of such men as E. S. Fedorov (1853–1919) and F. Y. Levinson-Lessing (1861–1939). One of the most prominent Russian petrologists at the present time is Alexander Nikolaevich Zavaritzky, who was born in 1884 and for twenty years occupied the chair of petrology at the Mining Institute at Leningrad, one of the oldest establishments of its kind in the world.

It may be truly said that at the present time the development of science in the U.S.S.R. is characterized by a widespread interdigitation of the pure and the applied sciences. As a matter of fact this tendency was already manifest even before the Revolution of 1917, and in Zavaritzky we can see a typical representative of this tendency. In his first work on the platinum deposits of the Urals published in 1909, Zavaritzky successfully applied petrological methods to the elucidation of the difficult problem of the genesis of platinum, work which he continued later, and in 1928 he published a more extensive account. Following up the ideas expressed by some American petrologists and by A. P. Karpinsky, he rejected the previously held opinion that platinum was an early product of the crystallization of an ultrabasic magma, and definitely demonstrated that, together with chromite, platinum was formed by the late magmatic fluids. These fluids or mineralizers, as they are frequently called, formed part of the scientific *credo* of Zavaritzky, and in this he shared the opinion of many modern petrologists. This attitude towards the part played by the volatiles contained in the magma determined his subsequent work and made him revise previously held opinion on the genesis of the world-famous magnetite ores of the Urals. In 1922 he published a most important work on the magnetite deposits of Mount Magnitnaya, which was afterwards amplified and revised ("Mount Magnitnaya" in the guide of the International Geological Congress, Moscow, 1937). He proved that the magnetite ore is not a product of magmatic segregation but is of a contact pyrometasomatic type replacing limestone of Carboniferous age adjoining intrusive granite. This new idea completely altered the character of the prospecting work in this area, and eventually led to a new and extensive mining of the ore which began in 1931, and to the construction of the greatest assemblage of blast furnaces in the U.S.S.R. and the building of the entirely new town of Magnitogorsk. The vastness of this enterprise is shown by the amount of extracted ore, which just before the War has risen to well over 5 million tons per annum, as compared with 20,000 tons per annum extracted before the Revolution.

Zavaritzky's work on the Uralian deposits of copper and iron pyrites is of no less importance. Since 1926 he has produced a series of papers on this subject in which he has gradually developed a new theory of the formation of these deposits. According to the previously held opinion, these ores were formed during the later phases of Uralian orogenesis and were deposited along tectonic crush zones. By discovering deposits of these ores among the less metamorphosed rocks of the southern Urals, Zavaritzky has been able to prove that the metamorphism affected the ores only long after their formation and that the original ores were formed from magmatic fluids associated with the eruptive activity of the Devonian period. This theory not only opened up new avenues in the study of Uralian rocks, but also provided a useful guide for future prospecting; and many new localities of pyritic deposits have since been discovered among the less metamorphosed lavas and tuffs.

Zavaritzky's contributions to pure science are equally important. Unlike some petrologists, he is extremely averse from framing sensational hypotheses and indulging in nebulous speculation about the origin of rocks. All his work is characterized by a mastery of his data and a strict interpretation of facts in the light of physico-chemical laws and mathematical reasoning. This mastery of facts and attention to detail is clearly seen in his excellent description of the peridotite massif of Rai-Iz in the polar Urals, published in 1932, and in the description of other peridotites from the same region, published in 1937. In this work, using his field and laboratory data as a starting point, he went deeply into a discussion of the processes of metasomatism, hybridization and contamination and all their bearings on petrogenesis.

Besides the Urals, Zavaritzky has made himself at home in another part of the U.S.S.R.—the far-distant peninsula of Kamchatka—a magnificent volcanic region containing nearly a hundred and thirty active and extinct volcanoes. In 1931 he began exploring the volcanoes of Kamchatka, on which subject he published several papers, and at the present time he is director of the Volcanological Station on Kamchatka. He is also responsible for many works dealing with Uralian volcanicity and tectonics, with various igneous, metamorphic and sedimentary rocks and on the classification of ore deposits.

Probably the most characteristic feature of Zavaritzky's work is his insistence on precise observation and on a strictly logical method of deduction. This explains the meticulous presentation of field and laboratory data and the interest he attaches to the optical study of rock-forming minerals. As his successor in the Mining Institute, he improved Fedorov's method of the universal stage, especially as applied to the determination of feldspars under the microscope; and he also worked out various refined methods for the determination of birefringence, refractive index, optical sign and other optical constants of the minerals.

At the same time Zavaritsky is probably the greatest authority in the U.S.S.R. on petrogenesis and on the application of physico-chemical principles to petrology. In his book "Physico-Chemical Principles of the Petrography of Igneous Rocks", published in 1926, he gave an excellent summary of the application of the phase rule and equilibrium diagrams to the study of artificial melts and magmas, combined with a critical discussion of the methods used and results achieved. In this book he also introduced a new method of graphic representation of rock analyses, a method which he later developed and which he has now used as the foundation of a most elaborate treatise on the chemical composition of igneous rocks, recently published under the title "Introduction to the Petrochemistry of Igneous Rocks" (*Pub. Acad. Sci. USSR*; 1944). This book of 321 pages will be of great value to petrologists of other countries provided they can read Russian, for it

contains an elaborate discussion of the petrochemistry of various well-known petrographical provinces as well as very valuable chapters on geochemistry and crystal chemistry in relation to the composition and mode of formation of igneous rocks and an interesting discussion on the problem of rock classification and differentiation of magma. It would be rather difficult to explain here in detail his graphical method of representation of rock analyses which, in its essence, is a complete geometrization of chemistry. This method, in brief, consists in the recalculation of the chemical analysis as a number of coefficients expressing the relative amounts of chemical elements, and then the ten coefficients thus obtained are plotted on an opened-up rectangular tetrahedron. Each analysis is represented by two vectors the position, length and inclination of which characterize the composition of the rock in question. By means of these diagrams he is able to survey large assemblages of rocks and also to compare various assemblages and discuss the problems of petrogenesis. Whether this method is really more efficient for coping with these problems than the previously devised schemes of Osann, Niggli, Wolff and others, can only be tested by an actual trial.

In his latest paper (*Bull. Acad. Sci. URSS*, Ser. Geol., No. 5, 12; 1944) Zavaritzky returns to the discussion of the equilibrium diagrams as applied to systems composed of a silicate melt and a volatile constituent. Although only an ideal case is discussed, his elaborate analysis of the processes which are liable to occur in this system through changes in concentration, temperature or pressure has an important bearing on the genesis of pegmatites and hydrothermal veins.

In conclusion, one can truly say that Zavaritzky has really made very important contributions to the progress of petrology and especially to the problems of petrogenesis and ore genesis, and it is only because the Russian language is not better known among scientific workers of other countries that his work has not been fully appreciated. It is true that many of his works have been abstracted in the *Mineralogical Abstracts* published by the Mineralogical Society, but no abstract, however full, can adequately represent the original. Adherence to facts and methods of exact observation are the main characteristics of Zavaritzky's work, and in his own words: "I consider that the fundamental object of science is the acquisition of the knowledge of new facts about real things and a precise statement of such facts and not agreement with such or such hypothesis, postulate, opinion or idea".

GLACIAL GEOLOGY IN HOLLAND DURING THE WAR

By D. DE WAARD
Mineralogical Geological Institute, University of Utrecht

DURING the War, Dutch geological students were unable to undertake much of the field-work usually done in foreign countries. Most of them carried out research on the carboniferous and cretaceous beds in the south of the Netherlands, or the tertiary and younger formations in the rest of the Netherlands. The following is a brief summary of progress made in geological research on the glacial Pleistocene in the Netherlands during the War.

For some decades, it was a well-known fact that, though all research pointed to only one glaciation having covered a part of the Netherlands especially during the Riss glaciation, yet remarkable differences are found in the kinds of sedimentary erratics in the boulder clay from different localities. These differences have been ascribed to variations in the direction of the glacial stream within the Baltic Sea area, whereby East and West Baltic erratic associations appear near each other in the boulder clay.

Besides these, great differences have recently been found in the proportions of recognizable crystalline erratic rocks in the north-east Netherlands. Usually the associations of the recognizable crystalline erratics contain only about 20 per cent East Baltic stones, consisting of Rapakivi granites from the Ålands Isles and southern Finland, and other kinds of stones from this area. This percentage proved to be typical of the deposits of the Riss glaciation. So it was very interesting to find in the north-east Netherlands an association with a much higher percentage of East Baltic rocks agreeing with the glacial deposits of the older Mindel glaciation in northern Germany. Some Dutch geologists have suggested as an explanation of these phenomena the existence of an older glaciation in this part of the Netherlands, though no other indications of a second glaciation have been found.

Further, some forty years ago, a theory of more than one ice-cover of a part of the Netherlands was based on the presence of different coloured boulder clays. This theory was rejected long ago, for the colour differences proved to be caused by normal weathering of the boulder clay. As, however, these arguments may be partly true, this theory should have further consideration.

To summarize, though only one glaciation has covered a part of the Netherlands, there are remarkable qualitative differences in the sedimentary erratics, quantitative differences in the recognizable crystalline erratics and—in addition to those caused by weathering—differences in the colour of the boulder clay, mainly found in the northern and north-eastern parts of the Netherlands.

More or less by accident, I found an explanation of these phenomena in the sea bottom of the former Zuyder Zee. Surveying the glacial deposits in the part of the Zuyder Zee reclaimed since 1940—the so-called north-eastern polder—between the former Isle of Urk and the old west coast near Vollenhove, I discovered several well-separated blocks of a typical boulder clay in the normal boulder clay. These blocks may be small or large, usually some 10–20 yards in diameter, mostly with an irregular outline and sometimes twenty within a square mile. They lie in the surrounding boulder clay, partly or wholly covered by it.

In contrast to the normal surrounding boulder clay, which in the unweathered condition is dark grey or nearly black and may be weathered to a rusty brown or even bluish-grey, the boulder clay of these separated blocks has a carmine or hæmetitic colour. None of the colours of the normal boulder clay in the weathering series approaches this carmine reddish colour.

Besides the colour differences, the boulder clay of the separated blocks differs from the surrounding boulder clay in a great many ways. For example, it contains mostly sedimentary erratics from the East Baltic area, not found in normal boulder clay; it has a high percentage of Rapakivi granites and other recognizable East Baltic crystalline erratics, while

the surrounding boulder clay has a normal low percentage; there are great differences in the percentages of lime and soluble iron, and also differences in the sedimentary petrology, in particular the percentage of dark minerals and the higher percentage of amphiboles, and the differences in the grain-size.

These differences indicate that these blocks of boulder clay have no connexion with the normal surrounding boulder clay. They must therefore have another origin. In view of the shape and the position in the normal boulder clay, it is clear that these are lenses or floes, composed of a different sort of boulder clay from the normal. It is probable that these floes are parts of another glacial deposit torn loose, embedded in the ground moraine and transported by the ice-cover during the Riss glaciation.

I have tried to find out from which glaciation these floes may have been formed. Indications of their origin may be the content of erratics. Both the east Baltic sedimentary rocks and the high-percentage Rapakivi rocks indicate a Mindel age. They resemble the autochthonic glacial deposits of the Mindel glaciation in the north of Germany.

In addition to the glacial areas on the bottom of the north-east of the former Zuyder Zee, I found these boulder clay floes in several different parts, about eighty altogether, of the north and east Netherlands. I should expect to find these floes in the adjoining Riss deposits in the north-east of Germany too. Their presence in the normal Riss deposits finally explains the abnormal east Baltic associations of erratics and the unusual colour differences of the boulder clay.

A detailed report on geological aspects of the existence, contents and spread of these boulder clay floes in the Netherlands will be published shortly.

BOWLING-GREENS AND BOWLS

By J. H. COLE and Dr. W. LAWRENCE BALLS, F.R.S.

IN Egypt, South Africa, and part of the United States, the bowling-greens have to be made with species of *Cynodon* (crested dogs-tail) grass, in order that they may stand up to summer heat. This grass, known to us in two or three species and many varieties, has a habit of one-sided growth, which imparts a one-way 'nap' to the playing surface, not only on bowling-greens but on putting-greens also. Both bowlers and golfers in these countries are used to seeing the ball run as if the whole surface of the green were sloping, though it may be dead level. The intensity of the effect varies from one strain to another: the Indian 'dhob' is the worst we have met; the less coarse Egyptian 'negeel' and the quarter-scale *C. transvaalensis* (called 'Uganda' in Egypt) both behave alike, though the latter is so much finer in texture as a lawn. On the other hand, a strain which is nap-free, known as 'Royal Cape', was isolated by Dr. Murray near Cape Town. We have checked this (with Mr. R. P. Black) in propagation plots at the Gezira Sporting Club in Cairo; it is, however, quite exceptional, and not easy to establish in Egypt.

The direction in which the nap points, and its intensity, can be measured in several ways. The earliest we used, and slowest but most direct, is to roll a ball of any kind down a chute towards all points of the compass in succession, and plot a polar diagram of the distances reached in each direction. The quickest, and most useful practically, since it will deal with a single square foot in each reading, is to oscillate a smooth six-inch disk of wood on the grass surface, noting the direction in which it moves, and how quickly; this can be done easily and accurately by using a light tripod about four feet high with an operating handle at the top, and a light duraluminium tube with universal joints connecting the disk to the handle at the top, without introducing any lateral displacement couple. Even now we are in doubt as to the components of the nap; it is not entirely superficial, since a green may show more nap after mowing than it had when uncut; we have even found traces of nap in a different direction under the predominant one. It would seem that the root-stocks of the grass build up a 'geological' structure recording the history of the nap.

Our earliest observations at the Gezira Sporting Club showed that the nap in 1930, under the regime of grass-control then employed, had a general trend to the north-west. Under our present regime of heavy manuring (sulphate of ammonia) and hard cutting, it points mostly west of south. The starting-point, with zero nap, is a lawn which has been 'skinned' of its grass-cover, and allowed to regenerate from the root-stocks. Six months later we have seen a slight westward nap in the late winter, a southward nap by the late summer, and finally a settling-down to south-west. But the settling-down is incomplete, and lawns which have not been skinned for years will still show changes over a swing of some seventy degrees, under the same regime, as the seasons change. Obviously the cause of nap is complex, but it would seem that its direction is determined primarily by water-strain, the precise development of the reaction thereto being determined by the balance of soil-moisture, manuring, and weather conditions. It need scarcely be added that the system of mowing is so arranged as to eliminate that possible cause completely.

Very strange bowl-tracks can be obtained when playing on such nappy lawns with the wrong kind of bowl, or when using the testing-chute. An English 'standard bowl' may take two feet of bias against the nap, but six feet with the nap, if the chute is set at right angles to the nap-direction. If set to bowl up and down the nap-direction, it may give even bias in both hands, but run several yards farther with the nap than against it. The effect on the muscular effort of the bowler is the same as if the green-surface were on the slope.

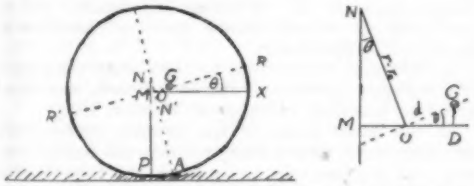
Bowls of modified shape give still stranger results. A flat track only half an inch in width, cut on the tread of a normal bowl, will make it entirely independent of the gravitational bias given it by its maker. Like a skater rocking from inside to outside edge, and back again, it will take a sigmoid course as the nap along its track changes direction locally. On a green with uniform and strong nap it is almost impossible to guess from its course which bias had been given; the nap takes complete control. As a limit case of this, instead of the cylindrical track, we can make a frustum of a cone, wider than it is high, when lying on its side; the path of this at low speed, or on a napless green, must be an arc of a circle, there being no gravitational bias; but if bowled fast on a nappy green against the nap it will turn a somersault.

It was noticed that bowls constructed by different makers were affected in varying degree. One Aus-

tralian make in particular was almost completely insensitive to cross-nap, while another make, an English one, had a tendency to reverse the nap-effect, taking more bias against the nap and less with it. Measurements on these and other bowls with a dial micrometer showed that the less nap-sensitive was the bowl, the more closely it approximated to a spherical form along its actual running-contact tread.

Conversely, the bowls which were most affected, sometimes fantastically, were found to have a radius of curvature across the tread which was much greater than the radius along the tread; for example, a 5 in. bowl, 2½ in. along the tread, might be 2⅝ in. across the tread. The running tread is only about an inch wide, so that such a bowl could be made spherical-treaded by removing only about 0·005 in. at the most. Steps were taken to correct the treads on a set of bowls which were badly affected, but since the re-shaping depended on cutting to limits well inside 0·001 in., it looked like a tool-maker's job to centre each bowl correctly in a lathe. This was practically impossible, when some fifty sets, and more, of club bowls were concerned. It was found, however, that a simple cradle arrangement over a mandrel, with a ball-bearing back-stop and lateral shims between bowl and cradle, gave sufficient drive to allow the use of a scraper. Several sets of bowls were thus converted, taking about half an hour per bowl; they were picked out of the cradle at intervals and tested across the track to a gauge of the same curvature as that which would fit along the track. The lathe was replaced by a sewing-machine stand, and the demand for re-shaping in the Gezira Sporting Club exceeds the supply of willing skilled operatives.

The cause of the reaction of the bowl to the nap is at present uncertain, just as is the causation of the nap itself. But observations show that bowls running across the nap show a marked tilt of their axis of rotation, which may be deflected from the horizontal by as much as 20°. The axis is tilted up in the direction of the nap, just as if the pile of the grass were acting as a banking, and the bowl were running on the banking. We suspect that the effect on the bias is due to this tilting of the axis of rotation (see accompanying diagram).



SECTION ACROSS TRACK, BIAS BEING SET WITH THE NAP.

In the above figure, P is the centre of pressure on the grass, but owing to nap the point of maximum grip on the grass is at A, hence the tilt of the axis of rotation.

O, centre of bowl; G, centre of gravity; N, centre of curvature of section at P–A; PN, perpendicular to the ground at P; OM, perpendicular from O on PN; θ, angle of slope $= \angle MNO = \angle ROX$; ROR', axis of rotation; $OA = r_0$; $NP = r = NA$; $\therefore ON = r - r_0$; $OG = d$.

$\therefore MOD = MO + OD = (r - r_0)\sin\theta + d\cos\theta$.

$\therefore$ increase of bias distance $= MD - OG$, which is equal to $(r - r_0)\sin\theta - d(1 - \cos\theta)$.

For $\theta = 20°$, $\sin\theta = 0{\cdot}342$, and $1 - \cos\theta = 0{\cdot}060$.

Since d is of the order 0·1 in., then $d(1 - \cos\theta)$ is of the order 0·006 in., and so may be neglected in comparison with $(r - r_0)\sin\theta$, unless $r = r_0$.

The inclination of the spherical bowl is such as to set its median plane at right angles to the slope of the grass blades, in both directions and on both 'hands'. We omit any consideration of gyroscopic effects, which must exist at the beginning of the run of a bowl. Apart from this, the causes of bias are three-fold: first, the gravitational cause due to lateral asymmetry of the bowl; secondly, the shape cause, as exaggerated in the case of a conical 'bowl'; thirdly, the asymmetry of the lawn structure, as described above. English bowling-greens seem to be free from the latter complication; casual examination seems to indicate that similar one-sided growth happens in our English grasses and climate, but that it is random and localized to an inch or so, the end result being practical symmetry of grass-surface.

We hope that this communication may direct the attention of plant physiologists to an interesting problem, both in the comparison of *Cynodon* with other grasses, and in the comparison of varied ecological conditions on various grasses. We also hope that it may save some 'greens stewards' being blamed for levelling errors which have no existence.

ACCELERATION OF CHARGED PARTICLES

THE two most successful methods for accelerating charged particles to very high energies are those employed in the cyclotron and betatron. In the cyclotron, if a very large number of individual accelerations is required, there may be difficulty in keeping the particles in step with the applied oscillating electric field, especially when relativistic mass change causes an appreciable variation in the angular velocity of the particles.

E. M. McMillan (*Phys. Rev.*, 68, 143; 1945) has proposed a device, which because of the similarity in its behaviour to that of a synchronous motor, he has called a 'synchroton'. It is shown that a particle, the energy of which (called its 'equilibrium energy') is such that its angular velocity matches the frequency of the electric field, moves in a stable stationary orbit, and any displaced orbit, due to displacement in phase or energy of the particle, will tend to correct itself. In order to accelerate the particles, the value of the equilibrium energy must be changed by varying either the magnetic field or the frequency. The practical application of the method depends on the type of particles to be accelerated. In the case of electrons, the equilibrium value of the energy varies during the acceleration by a large factor and it is more practical to vary the magnetic field; for heavy-particle acceleration, the frequency may be varied. A possible design for such a 300-MeV. accelerator is outlined, and the construction at the Radiation Laboratory of the University of California at Berkeley is stated to have been planned.

D. W. Kerst (*Phys. Rev.*, 68, 233; 1945) has also outlined a method for increasing the energies of particles obtained by the betatron. The betatrons used to date have all followed the design of the original 1941 Kerst model (see *Nature*, January 26, p. 90), in which the flux density at the orbit of the electron is limited to a value less than half the flux density which can be used at the centre of the orbit

(that is, about 4,000 gauss at the orbit and about 11,000 gauss within the orbit). In the conventional design the flux linking the orbit and the field at the orbit were zero together. This need not be so; the flux linking the orbit can be biased reversely, so that the flux through the centre has a large negative value initially and changes to a large positive value during the acceleration process. Thus the flux density can be made to change by twice the conventional amount, with corresponding increase in the final energy of the electrons. A method of achieving this bias is described, and ways of overcoming difficulties in variation of the radius of the orbit during acceleration as a result of non-linearity of the magnetic characteristics of the iron are discussed.

Modifications in the design along these lines for a betatron of 250 MeV. were considered early in 1942 and the plans for construction at the University of Illinois were drawn up during the summer of 1945. Information received from Germany indicates that a similar plan for a 200 MeV. betatron was being drawn up there some time before the capitulation. It has been reported elsewhere that the 250 MeV. betatron will be used to investigate high-energy phenomena within the cosmic ray range, and that the cost of the machine and research laboratory will amount to approximately one and a half million dollars.

NATIONAL FRUIT TRIALS

IT seems appropriate that the Royal Horticultural Society's long-standing assessment of the relative merits of fruit varieties* should be published at a time when a vitamin-conscious but fruit-starved public might be interested in the expansion of Britain's orchards. The maturation of a long-term investigation, planned on sound lines, cannot fail to be an inspiration, and growers should find a considerable number of new varieties which would add more precision to the rather irregular behaviour of many present-day commercial fruit plantations.

The outstanding second-early dessert apple among the new kinds under test is Laxton's Fortune. It is a free and consistent cropper, with good commercial features. Lord Lambourne provides a new mid-season apple, but trees are often affected with 'chat-fruit' and 'rubbery wood', which reduce its commercial value. For apples stored until April, Winston seems the best of recent introductions, while Laxton's Superb and Sunset might be used instead of Cox's Orange for winter supplies of fruit. Culinary apples do not appear to provide anything new which is superior to Emneth Early, Grenadier or Bramley's Seedling. The advent of Marjorie's Seedling is perhaps outstanding among plums; it provides much better all-round qualities than Monarch, the standard variety for late cropping. It is, moreover, highly resistant to bacterial canker—a strong recommendation in view of the widespread nature of this disease.

The report continues with estimations of varieties of cherries, black currants, gooseberries, red currants, raspberries and strawberries. The two crops last mentioned are scarcely amenable to trial by neighbourly comparison, owing to their different reactions to virus diseases. Juxtaposition of tolerant and susceptible kinds introduces too many variables for experimental proof of varietal worth. Mr. Potter is alive to these difficulties and to many others. A series of appendixes will be valuable to many workers. Flowering periods of the best varieties of apples, pears and plums are tabulated, and the results of an extensive series of cross-pollinations of the new kinds are given. Sulphur-shy apples and gooseberries are listed. Several apparent synonyms have been found among recent introductions, and these are discussed. Varietal reaction to frost damage has been considered, and it appears that dessert varieties are on the whole less susceptible to this kind of damage than are culinary kinds. Trees grafted upon Malling stocks I and II were more resistant to frost than those worked on Malling type XII. Young trees appeared to be more susceptible than fully grown trees.

Many fruit varieties have been sent to sub-stations in various parts of England, and the behaviour of trees at various places provides the strongest argument for the extension of fruit trials, based upon the sound details of the Wisley scheme. Scotland, in particular, gives a climate altogether different from that at Wisley, and requires its own estimate of varietal worth. The National Fruit Trials have shown what can be achieved; their greatest future lies in geographical extension.

* "National Fruit Trials, 1921–1944", by J. M. S. Potter. London: Royal Horticultural Society, Vincent Square, S.W.1. Pp. 56. 5s., post paid.

LIVERPOOL OBSERVATORY AND TIDAL INSTITUTE

DURING the War, the publication of the annual reports of the Liverpool Observatory and Tidal Institute was discontinued, the last report issued for general circulation being that for 1939. Publication is now resumed with a combined report for the years 1940–45; this also embodies a centenary report on the Liverpool Observatory, which was opened in 1845. The Liverpool Dock Act of 1841 gave powers to the town council to build and maintain a marine observatory out of the dock dues; the early work consisted of time determination (the results being notified to ships in port by a time-ball), meteorological observations and forecasts, and the rating of chronometers. The first director, Hartnup, was a pioneer in showing the principal source of error in chronometers to be variable temperature, and he instituted the now standard tests in chambers at controlled temperatures.

In 1864 the Observatory, by then under the control of the Mersey Docks and Harbour Board, was transferred to fine new buildings at Bidston Hill.

In the early years of the present century, the astronomical work gradually fell into the background, and later wireless telegraphy made the time determinations unnecessary. More recently the meteorological work has declined, as the State organization for this purpose has developed. Nevertheless, the present report includes the usual meteorological summaries for each of the years 1940–44. Seismological work, which was started in 1897, has continued, and has a marine interest in connexion with the tilting of the land under the varying load of tidal water.

In 1929 the Observatory and the Tidal Institute, founded in 1919 as a joint enterprise of the University of Liverpool and the Mersey Docks and Harbour Board, were combined, and the flourishing young Institute became housed in the Observatory.

The main part of the report deals with the Institute's many activities during the War, especially

in providing tidal predictions for ports and coasts in widespread parts of the world. Another valuable work was the issue in 1941 of a new version, on original lines, of the "Admiralty Manual of Tides", by Dr. A. T. Doodson, associate director of the Observatory and Tidal Institute, and Commander Warburg, R.N.; during the War this was available only for service use; it is to be hoped that it will soon be freely on sale to the public. The Institute has also supervised the construction, during the course of the War, of a 30-component tide-prediction machine of the Doodson–Légé type, for the Soviet Government.

Emphasis is laid in the report on the fundamental research which underlies the Institute's activities; on this, rather than on the volume of work on tidal analysis and prediction, rests the main importance of the Institute.

THE DONZELLIS

By Dr. M. Nierenstein

DURING my stay at St. Felix in Venezuela my host, Dr. McPherson, suggested my going with him to Piaco, about twenty miles from St. Felix, where he had to attend to the wife of the local butcher, Señor Materinus, who prided himself on having an old book on pharmacy, which Dr. McPherson thought might be interesting to me. However, the great attraction was the 'comadrona', the best midwife in the State of Bolivar, in the United States of Venezuela. She was a remarkable woman and had Indian, Spanish and Chinese blood in her veins, but she was a comadrona *par excellence*. When we arrived she was already firmly established and the Materinus household was already trembling. As Dr. McPherson told me that he would have to be there for at least another day I gladly accepted Señor Materinus' suggestion to go with him to Tucupita, which only meant crossing and recrossing the Orinoco by the luxurious Government ferry, and luxury and comfort meant a great deal to me after a prolonged stay on the Orinoco.

The visit to Tucupita with the object of meeting the friend of Señor Materinus, Señor Donzelli, a pharmacist at Tucupita, will be memorable to me. Again, I was attracted by the name Donzelli, as on examining Señor Materinus's old book on pharmacy I found that it was nothing else but the "Antidotario Neapolitano corretto" (1649) by Giuseppo Donzelli, of which I had seen several copies in London and elsewhere[1].

As nothing is known of the life of Giuseppo Carlo Donzelli and of his brother Henrico Antonio, I was glad to accept as a parting gift from my host, Señor Fernando Donzelli, the papers, mainly correspondence, of the Donzelli family which dated back to about 1523 and which I have used as the material of this short account.

In 1547 Danielo Giuseppo married Fräulein Maria Fordon of Hamburg, they had two sons and a daughter, Helena Carolina, who in 1581 married her cousin Giuseppo Donzelli. Their eldest son, Giuseppo Antonio, married in 1602 Miss Mary Clapperton of Leeds. They had a family of four, but only Giuseppo Carlo, born in 1607, and Henrico Antonio, born in 1619, survived.

Giuseppo Carlo entered the University of Padua at the age of nineteen, when he qualified after five years study and took his M.D. four years later, his thesis being, "De functionibus nervorum faci et olfactus organi". At the age of thirty he settled down in general practice at Naples, where he died in 1700. He married twice but nothing is known of his family.

Henrico Antonio[2] entered the University of Padua at the age of eighteen, where he showed ability and qualified at the age of twenty-two and took his M.D. the following year. His thesis, "Historia febris anomalæ", gained him the prize of the Academy at Rome for the best M.D. thesis of all Italian universities of the previous year. After three years as lecturer in general medicine at Padua, he was appointed professor of medicine at Rome, where he finally became the senior professor of medicine and head of the Medical School. He died at the early age of fifty-one, leaving a widow—a Peruvian by birth—and an only son, Innocenzo, aged seven. Both mother and son went soon after the death of the father to Lima, where the mother died when Innocenzo was ten years old, who thus became the ward of the viceroy.

Lima was then the capital of all the Spanish colonies in America and the centre of culture, and after a sound schooling at Lima young Innocenzo went to Spain when he was sixteen years of age and entered the University of Madrid at the age of nineteen, where he studied medicine and qualified at the age of twenty-five. The following year he took his M.D., his thesis being "De natura et causis fluiditatis sanguinis naturalis et deperditæ". With the King of Spain's permission he returned to Peru and devoted himself to the study of Peruvian pharmacy and botany. In 1718 he published at Lima his "Pharmacopoea Peruviana" and in 1727 the three volumes of his "Las Plantas d'El Peru", which was printed at Madrid[3]. At the age of forty-three he married at Lima Señorita de la Perriera, the daughter of a well-known physician at Lima. There was only one son, Carlo Antonio, who studied science at Lima and taught botany at several of the South American universities[4]. My friend Señor Donzelli at Tucupita[5] was a descendant of this Carlo Antonio Donzelli of Lima. The love for medicine is, however, still latent in the Donzelli family. When I was in Tucupita I did not meet the eldest son of Señor Donzelli, as he was away as a third-year medical student at the University of Carácas. His father told me that his son intended to specialize in surgery and to do post-graduate work in England. This was, however, in 1937 and much has happened since.

[1] The "Antidotario" seems to have been well thought of, to judge by the following references to it I have seen: Menz, "Oenopolium polypharmacum" (Herbipolæ, 1652); Woodward, "State of Physick" (London, 1704); Andry, "Traite des Alimens", 2 vols. (Paris, 1713); Giuseppo Donzelli is, however, better known for his "Teatro Farmaceutico" of which there were from 1661 to 1677 five editions listed by Gmelin, "Geschichte der Chemie", 3 vols. (Göttingen, 1797–99). Ferguson, "Bibliotheca Chemica", 2 vols. (Glasgow, 1906) gives a full description of the "Teatro Farmaceutico".

[2] Henrico Antonio Donzelli wrote the following books: 1. "Problemata excerpta ex commentariis Galeni in Hippocratem" (Romæ, 1657); 2. "Philonium pharmaceuticum et chirurgicum" (Romæ, 1666); 3. "De Alexandro Benedicto Veronensis" (Romæ, 1667).

[3] The only reference to the "Las Plantas D'El Peru" by Innocenzo Donzelli I have seen is Florea, "Historia de la Medicina en México desde la época de los Indios hasta le presente", 3 vols. (México, 1886).

[4] I understand that Carlo Antonio Donzelli wrote a botany of Bolivia, which I have not seen.

[5] Señor Donzelli at Tucupita was president of the Naturalist Society of the Delta Amacuro when I was there. He had been the editor of the journal of the Society for more than twenty years, and he told me that the membership of the Society was more than three hundred. He gave me a copy of the journal for 1935, which contained much interesting botanical, zoological and archæological material.

FORTHCOMING EVENTS

(Meeting marked with an asterisk • is open to the public)

Monday, March 25

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the ELECTRODEPOSITORS' TECHNICAL SOCIETY, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Continuous Electro-Tinning of Steel Strip in the Manufacture of Tinplate" (to be opened by Mr. C. Frenkel), and "Electrical Equipment for Continuous Strip Electro-Tinning Lines" (to be opened by Mr. P. F. Grove).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Major C. A. Hart: "Air Survey".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 7 p.m.—Prof. G. Schlesinger: "Japan's Industries" (lantern slides).

Tuesday, March 26

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "The Atomic Structure of Minerals".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. P. E. Vernon: "Statistical Methods in the Selection of Navy and Army Personnel".

Wednesday, March 27

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1944 to October 1945".

INSTITUTE OF PETROLEUM (at the Royal Institution, Albemarle Street, London, W.1), at 5.30 p.m.—Sir William Fraser: The First Cadman Memorial Lecture.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5.30 p.m.—Sir Jack Drummond, F.R.S.: "Famine Conditions and Mal-Nutrition in Europe".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. E. Seymour Semper and Mr. L. J. Hancock: "Plate Edge Preparation for Welding by Oxygen Cutting and Gouging".

THE POLYTECHNIC (in the Fyvie Hall, The Polytechnic, Regent Street, London, W.1), at 6.30 p.m.—Mr. George Archibald: "The Film To-day", 6: "The Future of the Film".•

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting of the MEDICAL, INDUSTRIAL and SOCIAL PSYCHOLOGY SECTIONS, at Bedford College, Regent's Park, London, N.W.1), at 7.30 p.m.—Discussion on "Problems of Resettlement" (to be opened by Gertrude Williams, D. J. Clarkson, Elliott Jaques and A. T. M. Wilson).

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Use of Scientists—Management in Research Laboratories" (Speakers: Dr. C. Gordon, Prof. N. F. Mott, F.R.S., Mr. A. P. Rowe and others).

Thursday, March 28

INSTITUTE OF FUEL, MIDLAND SECTION (at the James Watt Memorial Institute, Birmingham), at 2.30 p.m.—Mr. W. A. Moorshead: "Waste Heat Recovery in the Glass Industry" (Industrial 'Waste Heat' Recovery Series, 8).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. H. Fröhlich: "Theoretical Physics in Industry", 1: "Free Electrons in Solids".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. John P. Mandeville: "Improvements in the Methods of Census and Survey Analysis".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Squadron-Leader T. D. Weatherhead: "Air Photography and Civil Planning".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (joint meeting with the SCIENTIFIC AND TECHNICAL GROUP OF THE ROYAL PHOTOGRAPHIC SOCIETY, at Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m.—Mr. C. W. Bunn: "Towards Atomic Photography".

Friday, March 29

PHYSICAL SOCIETY, OPTICAL GROUP (in the large Physics Lecture Theatre, Imperial College, Imperial Institute Road, London, S.W.7), at 3 p.m.—Demonstrations.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Benny Lockspeiser: "Progress in Aeronautics".

Saturday, March 30

AMATEUR ENTOMOLOGISTS' SOCIETY (at Buckingham Gate Central School Hall, Wilfred Street, Victoria Street, London, S.W.1), at 2 p.m.—Exhibition of Apparatus, Methods and Insects.

Monday, March 25—Friday, March 29

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 5 p.m.—"Practical Problems which faced Medical Science during the War". Second week: "Problems of Efficiency".

(Monday: Visual, Auditory; Tuesday: Psychological; Wednesday: Respiratory; Thursday: Nutritional; Friday: Restoration to Efficiency.)

Tuesday, March 26—Friday, March 29

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2).—Radiolocation Convention.

Tuesday, March 26

At 5.30 p.m.—Sir Robert Watson-Watt, F.R.S.: "The Evolution of Radiolocation".

Wednesday, March 27

At 9.30 a.m.—"Aerials and Waveguides"; at 2.30 p.m.—"Propagation" and "Cathode-Ray Tubes"; at 6.15 p.m.—Mr. W. A. S. Buiement: "Precision Radar".

Thursday, March 28

At 9.30 a.m.—"Valves"; at 2.30 p.m.—"Radio Measurements and Test Gear"; at 6.15 p.m.—Mr. A. W. Rose: "Problems in Shipborne Radio".

Friday, March 29

At 9.30 a.m.—"Transmitters and Receivers"; at 2.30 p.m.—"Circuit Techniques for Radiolocation"; at 6.15 p.m.—Dr. R. A. Smith: "Radar in Navigation".

Wednesday, March 27—Thursday, March 28

FEDERATION OF BRITISH INDUSTRIES (at Kingsway Hall, Kingsway, London, W.C.2).—Conference on "Industry and Research".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURERS, one for MECHANICAL ENGINEERING, and one for MECHANICAL AND CIVIL ENGINEERING, in the Rotherham College of Technology—The Director of Education, Education Offices, Rotherham (March 29).

HEAD OF THE ENGINEERING DEPARTMENT—The Principal, Technical College, West Hartlepool (March 29).

ASSISTANT LECTURER IN PHARMACOGNOSY—The Registrar, University College, Nottingham (March 30).

CHEMIST for a post in India, to act as personal assistant to the Head Chemist—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.64.A (March 30).

SENIOR PALÆONTOLOGIST with all-round experience and some practical knowledge of Micropalæontology (Ref. No. G.48), a MICROPALÆONTOLOGIST specializing in the Foraminifera (Ref. No. G.47), and a MICROPALÆONTOLOGIST specializing in the Ostracoda (Ref. No. G.46), in the Geological Research Centre of a major Oil Company—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 30).

EDUCATIONAL PSYCHOLOGIST on the staff of the Child Guidance Clinic—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (March 30).

BASHFORTH PROFESSOR OF MATHEMATICAL PHYSICS, a PROFESSOR OF CHEMISTRY, and a PROFESSOR OF INSTRUMENT TECHNOLOGY, at the Military College of Science—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, endorsed 'M.C.S.' (March 30).

ASSISTANT LECTURER IN MATHEMATICS, and an ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (March 30).

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Municipal College, Portsmouth (March 30).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Assistant Registrar, University College, Southampton (April 1).

ASSISTANT PUBLIC ANALYST—The Town Clerk, Town Hall, Manchester 2, endorsed 'Assistant Public Analyst' (April 3).

COUNTY ANALYST—The Clerk to the County Council, County Buildings, Stafford (April 6).

METALLURGIST FOR GEOLOGICAL DIVISION of the Lands and Mines Department, Tanganyika Territory—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.113.XA (April 6).

METALLURGIST/CHEMIST to the Government of Uganda—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.112.XA (April 6).

ASSISTANT VETERINARY INVESTIGATION OFFICER—The Registrar, The University, Reading.

EXPERT IN ENTOMOLOGY, and an ENTOMOLOGIST, by the Government of Iraq in connexion with plans for agricultural development—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.12711.

RESEARCH ASSISTANT (BIOCHEMISTRY) in the Clinical Laboratory—Dr. C. P. Stewart, Royal Infirmary, Edinburgh.

PHYSICISTS, MATHEMATICIANS with qualifications in Physics and/or Statistics, CHEMISTS, Physical and Biochemical, BIOLOGIST, MECHANICAL ENGINEER and a CHEMICAL ENGINEER, for senior and junior scientific posts—The Secretary, Wool Industries Research Association, Torridon, Leeds 6.

AREA SUPERVISOR to supervise the work of the National Milk Testing and Advisory Scheme in South Staffordshire and to take charge of the Wolverhampton Area Laboratory, and a RESEARCH ASSISTANT in the Department of Bacteriology—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

CHIEF LECTURER IN CIVIL ENGINEERING, and a LECTURER IN PHYSICAL CHEMISTRY—The Principal, College of Technology and Commerce, The Newarke, Leicester.